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THE IRON AND
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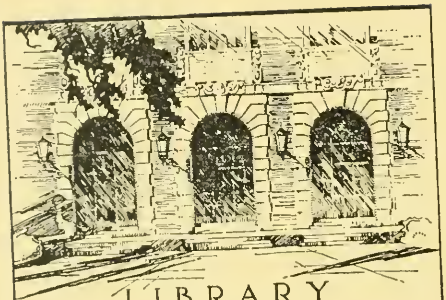

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THE IRON AND STEEL INDUSTRY OF THE CALUMET DISTRICT

A STUDY IN ECONOMIC GEOGRAPHY

BY

JOHN B. APPLETON, Ph.D.

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THE IRON AND STEEL INDUSTRY OF THE CALUMET DISTRICT

A STUDY IN ECONOMIC GEOGRAPHY

By

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Assistant Professor of Geography
University of Illinois

PUBLISHED BY THE UNIVERSITY OF ILLINOIS
URBANA

PREFACE

The data on which the conclusions reached in this study are based have been collected in three ways:

(1) by field observation of conditions as they exist at the present time,

(2) by personal conferences with executive officials of the various iron and steel plants and associated industries,

(3) by library investigation of the available data in Chicago and at Washington, D. C.

Statistical material, even including that available in the evidence which was given before the Federal Trade Commission during the "Pittsburgh Plus" inquiry, is incomplete and not altogether reliable. Nevertheless, it has been possible to supplement and to check the published material through conference and field observation sufficiently to permit an evaluation of the present importance of the area from the standpoint of production. Suggestions as to probable future developments are based on conclusions which have been reached during the course of the investigation.

The author is indebted to the officials of the various iron and steel companies for their courtesy and co-operation. They have supplied much very useful information, and have made many helpful suggestions.

The United States Army Engineer of the Chicago District, the Indiana Harbor Belt Railroad Company, the Elgin Joliet and Eastern Railroad Company, and the Secretary of the Lake Superior Iron Ore Association, have supplied a number of useful maps.

The Editors of various trade journals, including *Iron Age*, *Coal Age*, *The Iron Trade Review*, and *Motorship*, have loaned a number of useful photographs and supplied references to published material.

The Wellman-Seaver-Morgan Company, the Columbus Mining Company, and the Illinois Steel Company, have supplied a large number of photographs.

The Chambers of Commerce at Chicago, Gary, Hibbing, Hammond, and Escanaba, have been very helpful.

The writer wishes to thank Professor Harlan H. Barrows, and Professor Wellington D. Jones of the University of Chicago, for their helpful suggestions, which have enabled him to organize and carry through the investigation, and to present his conclusions in the following study.

John B. Appleton

University of Illinois
December, 1925.

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INTRODUCTION

The Calumet Industrial District stretches along the southwestern and southern shore of Lake Michigan from the western limits of South Chicago to the eastern limits of Gary. It constitutes a part of Metropolitan Chicago, and although part of it lies in Illinois and part in Indiana, it is an economic unit.

The district is important chiefly because of its manufacturing, which centers around iron and steel. The character of the industrial development is obvious at a glance as one traverses the district, for across wide tracts of unused land the large mills, with their many smoking stacks, stand out in striking relief. A closer view shows large lake freighters discharging ore at the docks, on which lie great piles of ore, coal, and limestone, extensive and elaborate machinery for transferring this huge bulk of materials, trainloads of coal, coke plants, and noisy mills much alike externally, but within, fitted to the specialized needs of this industry of many ramifications.

Prior to the founding of the iron and steel plants, little or no industrial, residential, or even agricultural development had taken place in the district in spite of its proximity to Chicago. The marshy and sandy character of the land had left it largely waste. Consequently, when the steel interests recognized the value of the lake shore and the banks of the Calumet River for large scale industry, they were able to acquire all the land they needed in large blocks, because no subdivision for residential purposes had taken place. Subsequent to the development of industrial activities and consequent upon them, parts of the district have been subdivided and built up as residence and business districts. From the standpoint of the industries requiring large ground space, it is fortunate that subdivision and residential development did not precede them.

One of the chief requirements of the iron and steel industry was facilities for receiving ore by boat. There were no natural harbors on the lake front, and the mouth of the Calumet River required extensive improvement before it was accessible even to small lake boats. The low shore, the shallow water fronting it, and the character of the materials underlying both the land and the lake, unconsolidated sand and clay till, made the digging of

artificial harbors and canals, and the building of breakwaters, relatively easy and inexpensive.

The district, located at the southern extremity of Lake Michigan, lies athwart the route inevitably followed by a number of railroads to Chicago from the east and southeast. The industrialists, once their attention was drawn to the district, recognized the value of its existing transportation facilities by rail, and its potential facilities by lake, for the reception of coal, ore, and limestone, and for the distribution of iron and steel or other manufactured products.

Around the production and fabrication of iron and steel almost the entire economic structure of the district has been built. The smelting of iron ore, the conversion of the molten iron into steel, and the rolling of the steel into rails, bars, shapes, billets, etc., are carried out, in most cases, in the same plant, the products varying in different plants according to the degree of specialization carried on, and the market served.

The chief iron and steel producing plants, classified according to location, are:

(a) *Lake-side locations:* (west to east)
   1. Illinois Steel Company, South Chicago
   2. Youngstown Sheet and Tube Company, South Chicago and Indiana Harbor
   3. Inland Steel Company, Indiana Harbor
   4. Indiana Steel Company, Gary
   5. National Tube Company, Gary[1]

(b) *Calumet River locations:* (north to south)
   1. Federal Furnace Company, South Chicago
   2. Wisconsin Steel Company, South Chicago
   3. Interstate Steel Company, South Chicago

(c) *Indiana Harbor Canal location:*
   1. Jones and Laughlin Steel Company, Hammond[2]

By-product coke plants, which play an important part in the industry and in the operation of the furnaces, are, in most cases, located contiguous to the iron and steel plants.

The factories concerned with the fabrication of iron and steel are scattered throughout the district, but in most cases they are

[1]Approaching completion.
[2]Preparations for construction in progress.

located strategically with reference to sources of raw material and to railroad transportation. Their products are very diversified and comprise all types of manufactured iron and steel goods, especially those chiefly in demand in the territory served by Chicago, such as machinery, agricultural implements, cars, locomotives, wire products, and structural steel. Like the blast furnaces and steel mills, these plants require large sites. This is particularly true of those plants concerned with railroad or structural equipment, such as the American Tank Car Company and the American Bridge Company. Consequently, the Calumet District is particularly suitable for their location on account of the large amount of available land, as well as because of supplies of raw material produced within the district, abundant transportation facilities, and proximity to Chicago and the markets of the Northern Interior.

Urban centers have grown up around the several groups of iron and steel plants. In most cases these urban areas are separated by wide stretches of vacant land. Only in the western part of the district is there an almost continuous built-up area. This extends from South Chicago to Blue Island, and is concerned chiefly with the fabricating industries, which occupy that section of the district.

Certain industries, other than those concerned with the manufacture and fabrication of iron and steel, have been established in the Calumet District and have increased its industrial importance. The Buffington Portland Cement plant is the largest of its kind in the country. It is related closely to blast furnace operations, since slag is one of the more important of its raw materials. The oil-refining industry, carried on by the Standard and Sinclair Companies at Whiting, is very large. It functions under very favorable conditions. Abundant land, just beyond the congested areas, is available, the great Chicago market is at hand, and excellent railroad facilities give access to the rich markets of the Northern Interior. The Grasselli Chemical Company located its immense plant at Hammond for reasons similar to those that attracted the oil refineries to Whiting.

The Calumet River has superseded the Chicago River as the chief collecting and forwarding point for the grain movement from the Northern Interior to the East. Rail and water transportation

are excellent, and there are not the handicaps to the business that are inevitable in the heart of a great city.[3]

The purpose of this study is to explain the relation of the iron and steel industry of the Calumet District to natural environmental conditions.

The rapid development which has taken place in recent years is indicative of highly favorable conditions for the successful operation of iron and steel mills on a very large scale. Adequate areas of flat land, provided with transportation facilities which permit the assembling of raw materials and the marketing of finished products over a wide area with relative ease, and an abundance of suitable water, in addition to adequate labor supplies, all have proved great assets. Although the sources of ore are distant, this material can be obtained relatively cheaply owing to lake transportation facilities. Coal, too, is distant, and comes part of the way or all of the way by rail. This is the chief handicap under which the Calumet District labors in competition with the Pittsburgh Steel District, but the later development of the former has given it a more modern equipment, permitting the adoption of the latest practices for reducing costs of production, and thus largely, if not entirely, offsetting the handicap with reference to coal.

Within a few years the Calumet District has risen to third place in the United States as a producer of iron and steel. Probably no steel producing district is more advantageously located with reference to a large and growing market. This fact added to the natural advantages of the district, makes the cost of production lower there than elsewhere in the country. Owing to artificial regulations created by the "Pittsburgh Plus" system of basing prices, the natural markets for the Calumet products have not been developed solely for the advantage of that district. The elimination of these restrictions should cause a big increase of production in the Calumet District at the expense of the Pittsburgh District. The general opinion, as expressed by the press and officials throughout the Calumet District, points to great industrial expansion there in the next few years. South Chicago, Gary, Hammond, Indiana Harbor, and other cities, all anticipate a very rapid growth, owing to their strategic location with reference

[3]For a full discussion of the grain trade, see Hartshorne, R., *The Lake Traffic of Chicago*. (Doctor's Dissertation at the University of Chicago, 1924).

to the western and northwestern markets. Present indications point to the influx of many Pittsburgh and Youngstown fabricating companies into the Calumet District and therefore to an increased local demand for iron and steel.

The conclusions reached in this investigation may be summarized as follows:

1. The manufacture of iron and steel in the Calumet District represents an effective adjustment to local and regional equipment. (1) An abundance of vacant, flat land, available to the industry in large blocks at relatively low prices; a lake front which, though devoid of good natural harbors, could be readily improved for commerce because of the character of the terrane, and along which new land could be built with slag in the shallow off-shore waters; the ease and low cost with which the enormous volume of pure water required by the industry could be provided; and proximity to Chicago, with its abundant supply of labor and its commercial facilities, have proved to be the chief advantages of the local equipment. (2) The ability both to assemble in the district the requisite raw materials of the industry at reasonable costs and to distribute widely its manufactured products, together with those of the dependent fabricating plants, is the outstanding regional advantage. Ore, limestone, and coal (in part) are brought at low rates in vessels which themselves represent an adjustment to conditions of the Great Lakes, and are handled at the terminals by machinery designed to permit the accumulation of the maximum tonnage in the season of navigation. Unsurpassed rail facilities are insured by the many railroads which converge upon Chicago.

2. Within the district, the urban centers and the fabricating plants are grouped near the iron and steel mills. The latter adjoin the waterways, the Lake or the lower Calumet River, upon which they are so dependent. Present indications point to urban development in the pleasant morainic lands along the southern margin of the district, leaving the unattractive lands which are still vacant on the lacustrine plain for future industrial development.

3. The significant fact that the cost of producing iron and steel in the Calumet District is lower than anywhere else in the country is attributable to the advantages of the district already noted, to the very modern character of its plants, and to the highly scientific methods employed there.

4. The "Pittsburgh Plus" system of basing prices restricted production in the Calumet District, since because of it, eastern producers shared on equal terms the natural market of the Calumet producers. Its recent elimination should permit the free operation of geographic and economic factors. It seems highly probable, as a result, that the Calumet District will become the chief iron and steel-producing center in the country.

PART I

THE PRODUCTION OF IRON AND STEEL IN THE CALUMET DISTRICT

CHAPTER I

THE MAGNITUDE AND CHARACTER OF THE INDUSTRY

Approximately 22 per cent of the output of iron and steel in the United States is produced in the Calumet District. This productive capacity has been achieved in a remarkably short time, and if the rate of increase from 1908 to 1923 is maintained, the ultimate supremacy of this district over the Pittsburgh District is assured in the not distant future.[1]

The Local Significance of the Industry

The production of iron and steel is the most significant industry in the Calumet District, not by reason of the value of its products, nor because of numbers of men employed, but because it forms the basis of the great fabricating industries which have grown up around the iron and steel mills. A survey of the district shows how closely most of its economic development is related to the different phases of the iron and steel industries which form the chief outlet for labor in almost every community in the district. Gary and Indiana Harbor are exclusively "steel" towns. They were founded by the steel interests to serve the steel industries, and few other manufacturing activities have been started in them. A glance through the lists of industries carried on in the various cities in the Calumet District shows the preponderance of those whose basic raw material is some form of iron or steel.

The Status of the Calumet District with Reference to the Northern Interior and the United States

The Calumet District is the chief iron and steel producing center in the Northern Interior. The concentration of the industry can be shown more easily through the medium of the blast furnaces than by steel mills since it is less difficult to trace the movement of iron ore than that of pig iron. The size of the operation, the high cost of building blast furnaces, and the necessity for large scale production, exclude the erection of small furnaces.

[1]Federal Trade Commission, *Docket 760*, p. 133.

Out of a total of forty-eight furnaces in the Northern Interior, thirty-seven are concentrated in the Calumet District.[2]

This concentration is further shown by the consumption of iron ore. In 1922, the Calumet District received over 8,000,000 tons, out of a total importation by Illinois and Indiana of a little more than 9,000,000 tons.

The map (Fig. 2) showing the movement and distribution of Lake Superior Iron Ore indicates the tonnage received at the various consuming centers in 1924. The significance of the Calumet District in contrast with other smelting centers in the Northern Interior is clearly shown. Receipts of ore by Calumet ports are shown in Table I. All of these receipts are utilized in the immediate

TABLE I*

RECEIPTS OF IRON ORE AT CALUMET PORTS, 1901–1925

(Millions of Tons)

	South Chicago	Gary	Indiana Harbor	Total
1901	2.5			2.5
1902	3.4			3.4
1903	3.1			3.1
1904	2.6			2.6
1905	3.0			3.0
1906	4.2		.05	4.25
1907	4.5		.15	4.65
1908	3.2	.7	.15	3.85
1909	4.4	1.9	.13	6.43
1910	5.0	1.8	.3	7.1
1911	3.9	1.3	.35	5.55
1912	5.5	2.1	.5	8.1
1913	5.6	2.4	.45	8.45
1914	3.9	1.6	.7	6.2
1915	4.7	2.4	.7	7.8
1916	7.5	2.7	.8	11.0
1917	7.0	3.9	.9	11.8
1918	6.1	3.8	1.4	11.3
1919	4.7	2.5	1.1	8.3
1920	6.3	3.6	1.2	11.1
1921	2.6	2.3	.8	5.7
1922	5.0	2.9	1.1	9.0
1923	6.9	4.0	1.6	12.5
1924	4.5	3.1	1.5	9.1
1925	6.4	4.9	1.9	13.2

*Based on data supplied by the Lake Superior Iron Ore Association, 1925, and *Iron Ores of Lake Superior*, by Crowell and Murray.

[2]The 48 furnaces are distributed as follows:

Illinois 26 (Calumet District 21)
Indiana 16 (Calumet District 16)
Wisconsin 5
Missouri 1

Annual Report, Lake Superior Iron Ore Association, 1923 (Fig. 2).

vicinity, with the exception of the relatively small amounts sent to the four furnaces at Joliet, which are supplied from South Chicago. The rapid upward trend, especially since 1908, when the Gary mills began to function, is very noticeable in spite of the wide fluctuations from year to year. The year 1925 was a record for the Calumet District, and the impending completion of the National Tube Mills at Gary should lead to a further increase in ore receipts.

Since the bulk of the iron produced at the present time is converted into steel in its molten state, most of the blast furnace establishments form a part of the steel mills, in order that the iron may be utilized as soon as it leaves the blast furnace. In this way the expense of re-heating is avoided, and the cost of producing steel materially lowered. In Indiana, 95% of the iron is delivered in a molten state to the steel mills, in Illinois, 76%.[3] The difference can be explained by the fact that two large blast furnace establishments in Illinois have no steel departments and all their product is sold in the form of pig iron.[4]

The concentration of large steel mills corresponds closely with that of the blast furnaces, but there also are numerous small steel plants, scattered throughout Illinois and Indiana, because this branch of the industry can be carried out on a small scale. These smaller plants can produce steel ingots from scrap, or from pig iron and scrap combined. Consequently, they need not be located near the blast furnaces. Examples of these can be found at Chicago Heights, East Chicago, Terre Haute, and elsewhere. It is not possible to discover the total production of such plants, since no separate statistics are given. A number of the present large scale producers in the Calumet District began operations in just such a small way. In most cases they produced crucible steel, and, in more recent times, some electric steel, since the methods of producing both these types are suited to small scale operations.

The productive capacity of the steel mills can be used to show the importance of the Calumet District in the Northern Interior, since it is impossible to obtain figures of actual production. The steel plants in the Calumet District have a capacity of 8,545,935 tons per year. This is divided among six plants. The outstanding

[3] *U. S. Census Report*, 1919, IX, p. 391.

[4] a. The Iroquois Iron Company, at South Chicago, produces pig iron for the use of the Youngstown Sheet and Tube Company at Indiana Harbor.

b. The Federal Furnace Company, South Chicago.

feature is the enormous productive power of two of the plants, one of them at Gary and one at South Chicago, operated by the Indiana Steel Company and the Illinois Steel Company respectively. Together these have a capacity of over 5,000,000 tons, or more than 60% of the total productive capacity of the group. Of the others, that of the Inland Steel Company comes next with 1,000,000 tons, and that of the Youngstown Sheet and Tube Company third with about 700,000 tons. The two remaining plants are much smaller. The actual production of all the plants of the district in 1923 was about 6,000,000 tons, roughly, 22% of the total output for the United States.[5]

Illinois and Indiana have a productive capacity of 5,710,425 tons and 5,500,915 tons respectively, or a total of 11,211,340 tons. Of this amount the Calumet District possesses approximately 70%. About half the productive power of Illinois, and 86% of that of Indiana, is concentrated in the Calumet District.

The importance of this industry as compared with other types of manufacturing in Illinois and Indiana can be seen readily by comparing the number of workers employed. In 1919, Illinois had 753,458 wage earners engaged in manufacturing and other mechanical industries. Of these, 95,048, or 12%, were employed in the iron and steel industry, 2,129 in connection with blast furnaces, and 20,177 in steel mills and rolling establishments. The remaining 72,742 were employed in fabricating industries which depended upon blast furnaces and steel mills for their raw materials. Similarly, out of 331, 484 engaged in the same group of industries, Indiana had 60,871, or 18%, in iron and steel plants, the former employing 1,368 and the latter 22,362. The remaining 37,141 were employed in iron and steel fabricating plants.[6]

[5]Steel Ingot Capacity—Calumet District 1924
(Thousands of Tons)

Illinois Steel Company	2,975
Indiana Steel Company	2,450
Inland Steel Company	1,000
Youngstown Sheet and Tube Company	700
Wisconsin Steel Company	400
Interstate Steel Company	225

Based on the Report of the Federal Trade Commission, *Docket 740*, Exhibit 6858.

[6]*U. S. Census Report*, 1919.

In 1920, the eight blast furnace and steel mill establishments located in the Calumet District gave employment, on the average, to 20,000 men. These represented about 43% of the total number engaged in this industry in Illinois and Indiana, or approximately 5% of the total for the United States.

In the United States as a whole, the Calumet District ranks third in the production of iron and steel, Pennsylvania and Ohio being first and second, respectively.[7] Although there have been marked fluctuations in production from year to year, owing to market conditions, there has been a definite and marked increase, especially since 1908 when the Gary mills were built. The outstanding facts gained from a study of the statistics are, (1) the predominance of the Pittsburgh District in all phases of iron and steel production, (2) the relatively small part of the total which the Calumet District produces, (3) the fact that capacity production in the Calumet District in contrast with that in the leading district is in process of considerable extension.

The consumption of iron ore is a first rate indication of the relative importance of the Calumet District compared with the eastern centers. Table II shows the total shipments of ore from the Lake Superior Region and the amounts received at the Calumet ports. From this it will be seen that these received one-fourth of the total ore moved in 1925, and a little less than that proportion in 1923. In 1921 it was one-fifth, and in 1919, one sixth. These

[7]The Iron and Steel industry of Illinois, Indiana, Ohio, and Pennsylvania, is concentrated into three districts which do not coincide with political boundaries, namely:

(1) Western Pennsylvania and eastern Ohio—the Pittsburgh-Cleveland District.

(2) Eastern Pennsylvania—the Bethlehem District.

(3) Indiana-Illinois—the Calumet District.

No figures are available which will permit a comparison of production under this grouping. The United States Census Reports do not differentiate between eastern and western Pennsylvania. Consequently, the Calumet District has been compared with Pennsylvania and Ohio separately.

The consumption of iron ore by districts, in 1922, was as follows:

(1) Pittsburgh-Cleveland District ....39,800,000 tons
(2) Bethlehem District ....13,300,000 tons
(3) Calumet District .... 9,000,000 tons

These figures justify the statement that the Calumet District ranks third in the United States in the production of iron and steel.

Based on data published by the Lake Superior Iron Ore Association, 1923.

TABLE II*

Total Shipments of Lake Superior Ore and Receipts at Calumet Ports, 1901-1925

(Millions of Tons)

Year	Total Shipments	Receipts at Calumet Ports	Year	Total Shipments	Receipts at Calumet Ports
1901.......	21	2.5	1914	33	6.2
1902.......	28	3.4	1915	47	7.8
1903.......	24	3.1	1916	67	11.0
1904.......	21	2.6	1917	59	11.8
1905.......	34	3.0	1918	58	11.3
1906.......	37	4.25	1919	49	8.3
1907.......	42	4.65	1920	60	11.1
1908.......	26	3.85	1921	23	5.4
1909.......	42	6.43	1922	45	9.0
1910.......	43	7.1	1923	60	12.5
1911.......	33	5.55	1924	42.6	9.1
1912.......	48	8.1	1925	54.1	13.2
1913.......	50	8.45			

*Based on data supplied by the Lake Superior Iron Ore Association, 1925, and *Iron Ores of Lake Superior* (1923), by Crowell and Murray.

comparisons show the increasing relative importance of this district.

A characteristic of the Calumet District is the large size of the blast furnace establishments. The Indiana Steel Company's plant at Gary is the largest in America. It has 12 furnaces. The Illinois Steel Company at South Chicago has 11, and its plant corresponds in size with the largest two in the East, namely, the Carnegie plant at Pittsburgh, and that of the Bethlehem Steel Corporation at Johnstown. It should also be borne in mind that while all the furnaces in the Calumet District, with one exception, are of large size and recent construction, there are many small, old-fashioned furnaces both in Ohio and in Pennsylvania. Consequently, the average production per furnace in the Calumet District is higher than in these two states, and at the same time the most modern methods and conservation practices can be employed to reduce the costs of production.

In 1921, Illinois-Indiana, with 39 active blast furnaces, produced only 500,000 tons less than did Ohio, with 53 active furnaces, and one-half as much as did Pennsylvania with 91 (Table III).

The production figures also show another important fact. Except in the case of Illinois-Indiana, there was a lower production

TABLE III*

IRON AND STEEL PRODUCTION FOR SELECTED STATES

(Thousands)

	Year	Blast Furnace Production	Value of Blast Furnace Products	Number of Men Employed	Steel Production	Value of Steel	Number of Men Employed
		Tons			Tons		
U. S. A.	1914	23,269	$317,653	29	23,404	$918,660	249
	1919	30,543	794,466	42	34,027	2,828,900	375
	1921	16,618	419,771	19	19,279	1,481,659	235
	1923	40,163	1,007,613	37	44,521	3,154,324	388
Pennsylvania	1914	9,743	135,806	11	11,851	448,116	132
	1919	12,014	312,000	15	15,308	1,290,000	170
	1921	6,261	164,558	7	8,074	645,760	109
	1923	14,739	377,227	12	17,716	1,292,222	168
Ohio	1914	5,279	72,969	6	5,451	205,023	46
	1919	7,073	190,000	10	8,176	630,000	74
	1921	3,799	164,558	4	4,727	333,561	49
	1923	9,370	231,239	8	11,300	809,183	87
Illinois-Indiana	1914	3,000	25,861	2	3,433	123,878	26
	1919	4,821	110,000	3	5,746	370,000	44
	1921	3,263	77,413	2	3,948	239,743	29
	1923	6,861	173,650	4	8,139	459,635	49

*Compiled from U. S. Census Reports of Manufactures.

of pig iron in the various districts of the United States in 1921 than in 1914. Illinois-Indiana showed a slight increase. The total value of the product of Illinois-Indiana was $77,000,000 which was approximately two-thirds that of Ohio and one-half that of Pennsylvania. In 1923, the production in Illinois-Indiana was twice that of 1914, while the increase in Pennsylvania and in Ohio, though large, was less striking.

It will be noticed from the figures in Table III that many more wage earners are employed in steel and rolling mills than in blast furnace plants. This is due to the nature of the industry and the number of processes through which the steel passes before it emerges in merchantable forms. The actual making of the steel is only one phase of the industry. The three- or four-ton ingots pass immediately to the blooming and rolling mills for conversion into the forms in which the steel reaches its markets. Billets must be rolled, cut, rolled, and re-rolled into shapes, before they leave the mill. The processes are almost continuous, one following the other with a minimum of delay. Hence the number of men employed is large compared with the number needed in a blast furnace plant.

In 1921, there were three times as many men employed in blast furnace plants in Pennsylvania as in Illinois-Indiana, and four times as many in steel mills, while Ohio employed more than twice as many in both branches of the industry (Table III). There are marked fluctuations in the numbers from year to year, but it should be noted that Illinois-Indiana shows a slight increase in 1921 over 1914, and a very much greater one in 1923. The great additions made to almost all the plants there in 1919 were in part, if not altogether, responsible for the increase.

The numbers employed indicate clearly the trends of production. In 1921, the Illinois-Indiana output of steel, also, was greater than in 1914. An examination of the earlier figures for this district shows a consistent increase with much less fluctuation than occurred in Ohio or Pennsylvania. In 1921, Ohio produced less than 1,000,000 tons more than Illinois-Indiana, while Pennsylvania produced 3,000,000 tons more. It is noteworthy to remember that at least 70% of the 3,947,731 tons produced in Illinois-Indiana was contributed by the Calumet District. In 1923, the output of steel in Illinois-Indiana increased 100%. Elsewhere the increase was relatively smaller.

The influence of the war period, as shown by the figures of 1919, with its high prices and its high costs of labor and of materials, is evident from the much higher value of the products compared with 1914. This was due to the increased demand which resulted in higher prices and increased production. The value of the Illinois-Indiana production amounted to about one-third of the Pennsylvania production and two-thirds of that of Ohio. In 1923, the value of steel produced in Illinois-Indiana was more than double that of 1921 and four times that of 1914 (Table III).

The growing significance of the Calumet District as a production center for iron and steel is very evident. Extensions are in progress in every plant in the district. New furnaces for the production of iron and steel are being added. The new National Tube plant at Gary is being constructed rapidly. Other new plants are being considered. Jones and Laughlin of Pittsburgh have purchased 2,000 acres for a $100,000,000 steel plant at Hammond, adjoining the Indiana Harbor Canal. The Inland Steel Company has purchased 540 acres, adjoining 100 acres which it had previously acquired near Gary, in order to provide for future expansion. The Aetna Iron and Steel Company also has bought 400 acres at Gary for a steel mill. Several eastern steel-fabricating companies own large sites in the district which they are holding for future development. All of these projected plants will derive the major part of their raw material from the local steel mills. There seems to be abundant evidence for believing that this district is destined to become a second "Pittsburgh" in the iron and steel industry of the United States.

The Development in the Calumet District Accompanied the Decline in Chicago

Prior to the founding of the South Chicago works of the Illinois Steel Company at the mouth of the Calumet River in 1880, there was no industrial development in the district at all. Until that time the iron industry in this part of the country had been concentrated along the Chicago River near the heart of the city. It had developed from the small foundries which were built beside that navigable waterway in 1839.[8] With the increasing

[8]Andreas, A. T., *History of Chicago*, I, p. 567.

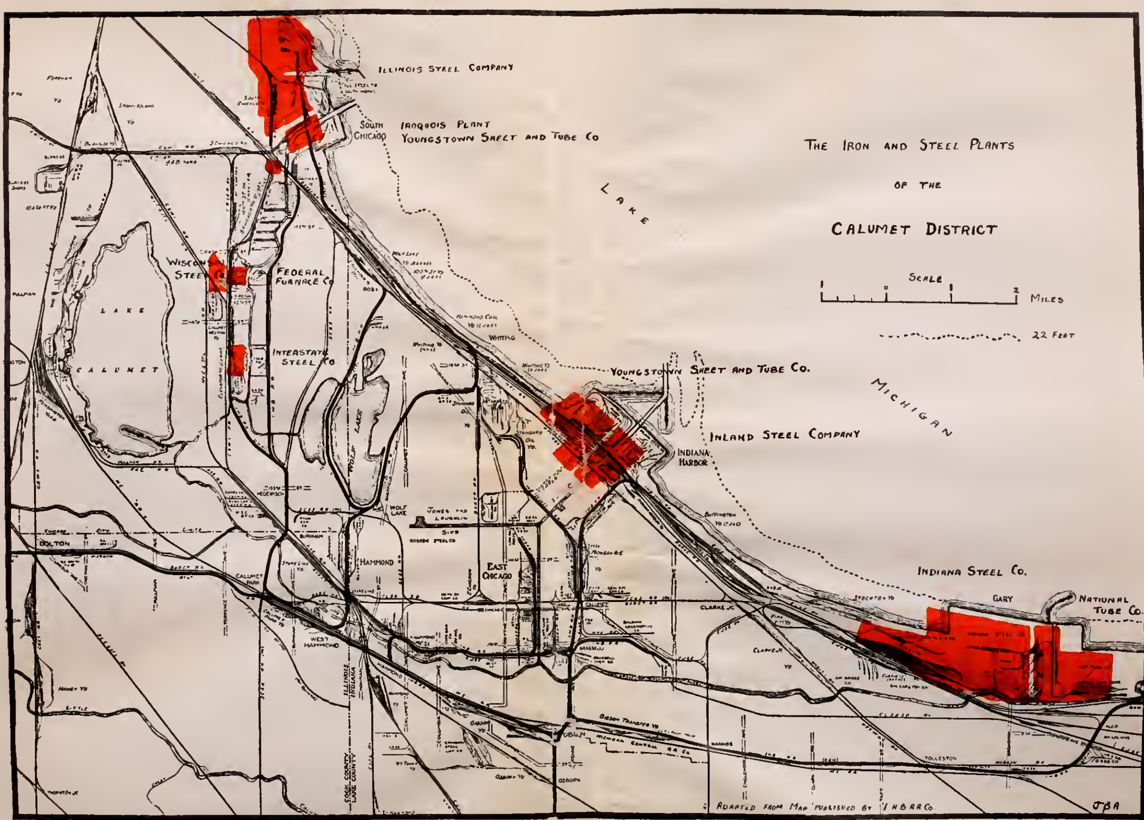
demand for products of iron and steel, these industries expanded rapidly. The great railroad building era of the 1850's and 1860's had encouraged the building of rolling mills for the production of iron rails. The local demand for iron together with the suitability of the high grade Brazil block coal of Indiana for smelting the Lake Superior iron ore which had become available because of the opening of the Soo Canal in 1855, was responsible for the building of the first blast furnaces in 1868.[9] Previously all the pig iron had been imported from the East. The success of these first local furnaces encouraged the erection of others, for the rapidly filling Northern Interior constituted a rapidly increasing market for all forms of iron, and, as railroad building progressed, a wider and wider area became tributary to Chicago.

With the adoption of the Bessemer process by the Chicago Rolling Mill Company in 1872, the industry received a still greater impetus.

Railroads made the greatest demands on the products of the rolling mills by their rapid adoption of steel rails in place of iron rails. As early as 1876, Chicago produced 85,000 tons of steel rails, which were almost one-third the total, 290,000 tons, for the United States.[10] It was to meet the demands for steel and for increased production that the first Calumet plant was built in 1880. From its very inception its main product was steel and not iron as in the case of the Chicago plants. The South Chicago mill was planned on a very much larger scale than the other plants in the city. This was practicable since it was located in an almost empty area where there was abundant space for industrial expansion, unhampered by urban development.

After 1880, the iron and steel industry in the Calumet District grew in size and scope, while it gradually declined along the Chicago River. At the present time there is no iron or steel smelted along the Chicago River. The old sites are used for other purposes more suited to congested urban areas. The Calumet District, on the other hand, has offered such material advantages that it has become the center of iron and steel production in the Northern Interior and the third largest producer in America.

[9] Andreas, A. T., *op. cit.*, II, p. 674.
[10] *Ibid.*, III, p. 471.



The Iron and Steel Plants
of the
Calumet District
Scale
Miles
22 Feet
Illinois Steel Company
South Chicago
Iroquois Plant
Youngstown Sheet and Tube Co
Lake
Michigan
Wisconsin Steel Co
Federal Furnace Co
Interstate Steel Co
Lake Calumet
Wolf Lake
Whiting
Youngstown Sheet and Tube Co.
Inland Steel Company
Indiana Harbor
Jones and Laughlin Site
Hammond
East Chicago
West Hammond
Calumet Park
Bolton
Indiana Steel Co.
Gary
National Tube Co.
Illinois
Indiana
Cook County
Lake County
Adapted from Map published by I H B R R Co.
J B A

Figure 1

The Distribution of Iron and Steel Plants Within the Calumet District

Two types of location are utilized as sites for iron and steel mills in the Calumet District. Six plants are to be found on the Lake Shore, and three along the improved lower course of the Calumet River (Fig. 1).

Lake Shore Locations.—By far the largest land holding along the lake shore is that of the United States Steel Corporation owned through the medium of its subsidiary, the Indiana Steel Company. The property extends along the entire shore from the corporate limits of Indiana Harbor to the eastern limits of the site occupied by the Gary National Tube Mills. The whole of it comes within the corporate limits of Gary. The eastern part of the property is occupied by the famous Gary Steel Mills and by the new National Tube Mills, which are approaching completion. The former are primarily producers of steel, and the latter also will give their main attention to this phase of the industry. Three fabricating plants are located in the western part of the property. The American Sheet and Tin Plate Company and the American Bridge Company are purely steel fabricating plants, dependent upon the steel mills for their raw material. Just within the western limits of the property are the Buffington Portland Cement Works, which were designed to utilize the slag from the steel mills for the production of cement. This is in essence a by-product industry. Much land between the various plants is vacant, and is held in order to accommodate the future expansion of the Corporations' activities, and, at the same time, to prevent other interests from getting a footing in that section of the lake front.

In its original condition the site occupied by the steel mills was purely a waste of dune and swamp. It has been developed at great expense on an enormous scale in the most modern and scientific manner.

When the United States Steel Corporation planned to extend its capacity by building a large plant in the neighborhood of Chicago, certain minimum requirements were laid down regarding the choice of the site. Its agents sought a moderately priced and compact tract of land centrally located in the Northern Interior, which provided a lake harbor with sufficient depth of water to accommodate the largest lake vessels in the ore fleet, together with adequate railroad facilities.

It happened that, in the late 1890's, the Meat Packing interests of Chicago were in conflict with the civic authorities, who complained of the nuisance created by the odors, of the pollution of the river, and of other disadvantages resulting from the location of that type of industry in one of the more congested parts of the city. Accordingly, the companies concerned combined to purchase 6,000 acres in one block in the Calumet District, on the lake shore, far removed from the then settled sections, with a view to moving their whole business away from the city. Their purchase consisted of desolate swamp and dune land located on the site of the Gary steel mills and the associated fabricating plants. The conflict was settled amicably and the Meat Packing interests remained in Chicago. In 1906, this lake shore property was purchased en bloc by the United States Steel Corporation. The property conformed in most respects to the requirements laid down for the selection of a mill site. There was no harbor, but one could be constructed with relative ease. In other respects no better selection could have been made. To have purchased a large area like this, in small lots, would have created a land boom, and prices would have soared. As it was, the deal was completed in one operation. The price per acre was in terms of hundreds of dollars, when under the other conditions it would have been very much higher. It is interesting to compare this transaction with the recent purchase by the Jones and Laughlin Steel Company, from the East Chicago Land Company and the State of Indiana. This site, being swamp land, had not been subdivided, and hence it was possible to purchase a large acreage in one block.[11]

The oldest established shore location is that occupied by the plant of the Illinois Steel Company at South Chicago. The first establishment on this site was the South Works of the North Chicago Rolling Mill Company, built in 1880 on a sandy beach on the north side of the mouth of the Calumet River. This particular site was chosen because of its proximity to navigable water, in an area which was then outside the city limits. Even before 1880, the company had realized the disadvantages of being located in the heart of Chicago, and its migration to the Calumet District was a natural move. The site chosen there was worthless for agriculture, but from the point of view of the steel smelter it was a very good

[11] *Pep in Calumet*, Hammond Chamber of Commerce, Oct.-Nov., 1924.

one. It also afforded ample space for future expansion. Indeed, with the later improvement of the harbor and river, and the dredging of the north and south slips, this became an excellent location. The expansion of Chicago has limited the possibilities for enlarging the site of the plant on the landward side, although in 1880 the owners considered they had a site large enough for all time. They did not realize what enormous growth was to take place in the industry. By 1906, most of the land that had been acquired had been occupied and further expansion was only possible by the acquisition of a new holding.

The plant of the Iroquois Company was established in the 1880's on the south side of the Calumet River, just above the mouth. The original plant still stands on the old site, and is closely surrounded by small iron and steel fabricating plants. It is used only occasionally for experimental purposes. The superior advantages of a location at the mouth of the river were quickly realized, and in the 1890's the Iroquois Company erected a new plant on the south side of the entrance to the river, opposite the Illinois Steel Plant. This site was larger, more easily accessible from the lake, and also offered all the advantages of a lake shore location. Since then, the plant has changed ownership twice. The American Steel and Tube Company first incorporated it with its plant at Indiana Harbor, and in 1923, both were absorbed by the Youngstown Sheet and Tube Company. Expansion of the site on the landward side early became impossible because of urban development. What vacant shore land remained was either dedicated to park purposes by the civic authorities, or became subdivided to such a degree that additional land was much too expensive to buy for industrial purposes.

Two plants occupy shore positions at Indiana Harbor. The Inland Steel Company first occupied this section of the lake shore in 1905. It was the nearest site to Chicago that could be obtained. Originally there was no harbor, but it was easy to dredge a slip in the loose lacustrine and glacial material. This was completed in 1906, and gave adequate harbor facilities to the expanding local industry. As a result, this part of the Calumet District was placed on terms of equality with South Chicago. The Inland Steel Company developed rapidly after this improvement, and became the largest independent producer in the Northern Interior.

In 1916, the American Sheet and Tube Company, which had been established for some years at Chicago Heights, migrated to the north side of the slip which formed the harbor, where a new plant was built with a lake frontage of 6,000 feet. It enjoyed the same facilities as its neighbor, and its rise was similarly rapid. In 1923, it was taken over by the Youngstown Sheet and Tube Company, and it now forms a part of that large organization.

River Locations.—Three plants are located on the improved section of the Calumet River in the neighborhood of 106th Street. These are all within the corporate limits of Chicago, although when they were first built the city had not spread so far east. All these river positions have been used for a comparatively long period. The reasons why the founders chose the particular sites can only be surmised. The history of the plants erected there is very obscure, as they have changed hands a number of times. There seems to be no doubt that they were founded in the 1890's, after the river had been somewhat improved. They were located near the margin of urban settlement, since the means of communication were such that close proximity to a built up area ensured a satisfactory labor supply. The river provided connection with the lake, and its subsequent improvement has given these plants similar advantages with regard to lake transportation and water supply as are enjoyed by lake shore plants.

Originally, the site of the Wisconsin Steel plant was occupied by a small iron company with one hand-filled furnace. This concern was purchased in 1901 by some of the members of the Deering family, who were interested in the manufacture of agricultural implements. When they formed the International Harvester Company, the iron plant was affiliated with that organization in order to supply it with iron and steel for the manufacture of agricultural machinery. Since that time the plant has been enlarged, but it maintains this intimate connection with the fabricating company, which consumes the bulk of its products.

The Federal Furnace Company is located on the east side of the Calumet River, opposite the Wisconsin Steel plant. At the present time it is a subsidiary of the By-product Coke Corporation. The site was chosen in the 1890's, when a small furnace company was founded. From 1912 to 1915 it was operated by Pickands Mather Company, who have extensive iron mines in the Superior

region. In 1915, it was amalgamated with the By-product Coke Corporation, but it was operated as a separate unit until 1922, when control was centralized.

The Interstate Iron and Steel Company originated at East Chicago in 1905, as a small crucible steel producing concern. From this inland site it migrated to navigable water by purchasing the steel plant of the Grand Crossing Tack Company, which was located half a mile above that of the Wisconsin Steel Company. In addition to the advantage of accessibility from the lake, the acquired property had good railroad connection with the company's tack plant at Grand Crossing, well inside the city limits.

The sites occupied by the two last named plants are comparatively small, but well in excess of present needs.[12]

Modern Methods and Equipment Reduce Costs of Production

Modern equipment, and the application of up-to-date methods, have made it possible for producers in the Calumet District to reduce their costs of production to such an extent that they have overcome the disadvantage of the high cost of bringing coal from eastern Kentucky and West Virginia. This has been accomplished chiefly by the careful utilization of by-products which could be substituted for coal. In turn, large scale production with modern equipment has enabled them to accomplish this. Judge Gary admitted that costs of production were 14% lower at Gary than at Pittsburgh, and the Federal Trade Commission at the hearing on "Pittsburgh Plus" conclusively verified this statement. In 1920, the Calumet District produced 456,308 tons, or 40% of the total United States tonnage of structural shapes, at a cost of $42.825 per gross ton. The Pittsburgh District produced 56.2% at $52.207 per ton. The Calumet District thus had the advantage of $9.342 per ton. This represents a difference in costs of 18% in favor of the latter. In the case of plates, the Calumet District manufactured 664,602 tons, or 32.7% of the total output of the country, at an advantage of 1.5% lower cost. In the same year 839,270 tons of merchant bars, or 35.7% of the

[12]For much of the above information the writer is indebted to the officials of the various companies.

United States production (2,347,913 tons) were made in the Calumet District at $4.638 per ton less than in the Pittsburgh District. These two centers produce all the black sheets that are made in the country, but costs are 9.3% lower in the Calumet District. The latter has an advantage over the Pittsburgh District in the cost of producing these four commodities of 14.5% (Table IV). In fact, steel can be produced cheaper in the Calumet District than anywhere else in the country. The highly effective organization of the industry there, the modern equipment employed, and the proximity to Chicago, are among the outstanding advantages of the Calumet District.

The Dominant Feature of the Industry Is Large Scale Production

Large scale modern units predominate in the Calumet District. They represent the results of consolidations and mergers. The development of large scale production requires an enormous outlay of capital, since the equipment of an iron and steel plant is particularly expensive. The nature of the industry requires a large acreage, which entails considerable initial outlay. The recent expenditure of the Jones and Laughlin Steel Company illustrates this fact.

The desire of the different corporations to control large reserves of raw material has been responsible in part for a number of mergers, since by amalgamating individual properties the resources for future use by the combined companies are better assured. The recent merger of the American Sheet and Tube Company with the Youngstown Sheet and Tube Company is an illustration of this tendency. The Inland Steel Company has been attempting a similar union with both Eastern and Middle West interests.

Most of the producers in the Calumet District already form units of some larger organizations. Thus the Illinois Steel Company and Indiana Steel Company are subsidiaries of the United States Steel Corporation, the Wisconsin Steel Company is a part of the International Harvester Company, the Federal Furnace Plant is a unit of the By-products Coke Corporation, and the Iroquois Iron Company, of the Youngstown Sheet and Tube Company.

TABLE IV*

RELATIVE MILL COST OF MANUFACTURING STRUCTURAL SHAPES, PLATES, MERCHANT BARS, BLACK SHEETS, IN PITTSBURGH, CHICAGO, DULUTH, BIRMINGHAM, 1920

	Production Gross Tons	Percentage of Total	Total Mill Cost			Number of Mills
			Per Gross Ton	Higher or Lower than Pittsburgh		
				Per ton	Per cent	
I. *Structural Shapes*						
Pittsburgh	640,123	56.2	$52.207	.....	......	9
Chicago	456,308	40.1	42.835	$9.372	18.0−	7
Birmingham	42,741	3.7	52.043	0.164	0.3−	2
Total	1,139,172	100				18
II. *Plates*						
Pittsburgh	1,208,249	59.5	48.659	.....	......	11
Chicago	664,602	32.7	47.907	0.752	1.5−	5
Birmingham	158,775	7.8	57.007	8.348	17.2+	2
Total	2,031,626	100				18
III. *Merchant Bars*						
Pittsburgh	1,333,890	56.8	50.319	.....	......	36
Chicago	839,270	35.7	45.683	4.636	9.2−	13
Duluth	110,963	4.8	58.445	8.126	16.1+	3
Birmingham	63,790	2.7	49.344	0.975	1.9−	2
Total	2,347,913	100				56
IV. *Black Sheets*						
Pittsburgh	558,911	84.2	85.891	.....	......	126
Chicago	105,233	15.8	77.894	7.997	9.3−	16
Total	664,144	100				144
Total						
Pittsburgh	3,741,173	60.5	55.430	.....	......	184
Chicago	2,065,413	33.4	47.410	8.010	14.5−	43
Duluth	110,963	1.8	58.445	3.025	5.5+	3
Birmingham	265,306	4.3	54.365	1.053	1.05−	6
Total	6,182,855	100				236

*Federal Trade Commission, *Docket 740*, Exhibit No. 6851.

Products

Iron and steel in almost all their forms are produced in the Calumet District, but the major interest is in steel products, since the demand for them is very much greater than that for iron products.

There are two establishments which produce pig iron only. The output of one of these, the Iroquois plant, is utilized almost entirely for steel purposes by the Youngstown Sheet and Tube Company at Indiana Harbor. The other establishment, the Federal Furnace Plant, produces pig iron for sale. It makes, in accordance with definite specifications laid down by purchasers, all grades and qualities of pig iron which are included under the terms basic, malleable, and foundry. In order to meet the requirements of the different iron fabricators, as many as fifteen different grades of ore are used. These are purchased as much for their magnesium, phosphorus, and silica content, as for the percentage of iron they contain, since the uses to which the iron is put are determined by the quantity of each of these substances. Thus a manufacturer of radiators demands a foundry iron which is high in phosphorus and magnesium, since these ingredients give the iron fluidity and greater strength. Many variations are provided in the chemical content of the three commercial types of pig iron used. The production of pig iron for commercial use entails very frequent changes in the mixture which goes into the furnace. On the other hand, when iron is being produced for steel purposes a furnace will run for months on practically the same mixture.[13]

There is some commercial production of pig iron by the blast furnaces attached to the steel mills. This includes any surplus that may be made, and also the Sunday or holiday production of the blast furnaces, which is converted into pigs when the steel plant is not working. There are, however, fewer variations in the chemical analysis of this pig iron than in the commercial product, and the market served is much less specialized. The steel companies sell pig iron because they prefer not to re-heat pigs, for this entails additional cost.

The two most common types of steel are produced by the Open Hearth and the Bessemer processes. Each has characteristics which make it suited to special uses, but Open Hearth steel is far superior to the other for most purposes. The tensile strength

[13]Blast furnace operations explained by superintendents.

of steel depends upon its chemical composition. By the Open Hearth method this can be controlled accurately during the "heat." In the case of Bessemer steel the product depends to a much greater degree upon the qualities of the molten iron used, as no changes can be made during the conversion. The demand for Open Hearth steel has become far greater than for Bessemer, owing to its greater range of use, and greater strength. Another factor has been important in connection with the production of Bessemer steel. This process necessitates the use of a much purer grade of pig iron than does the other. At the present time, the supplies of "Bessemer Ore" are much less than they were ten years ago. Indeed, the more accessible deposits are approaching exhaustion rapidly. The enormous demand for steel has necessitated the use of what is known as "Non-Bessemer Ore," which exists in much greater quantities, and the product from this is quite suitable for use in Open Hearth furnaces. Hence there has been a decline in the production of Bessemer compared with that of Open Hearth steel. The figures in Table V show the rapid increase in the production of the latter in the last fourteen years.

There seems to be a general consensus of opinion throughout the Calumet District that the peak production of Bessemer steel was reached some years ago, and that now it is a declining industry so far as this district is concerned. Until 1924, the Wisconsin Steel Company produced only Bessemer steel, but it has recently installed an Open Hearth equipment. The company is planning already to extend this department in the near future.

In 1921, Illinois and Indiana produced 3,947,531 tons of steel. Of this total 3,369,653 tons, or 84%, was made by the Open Hearth process, and only 565,839 tons were Bessemer. Table V shows the production of these two states for a number of years and the trend both in type and tonnage can be clearly seen.

Another important factor which has affected the production of Open Hearth steel is the fact that 50% of every "heat" is composed of scrap steel. The effect of this is to halve the consumption of pig iron. Thus with a given blast furnace equipment, a steel company which adopts the Open Hearth in place of the Bessemer process, can double its output of steel without any additional pig iron. This cuts down the capital expenditure on the plant and at the same time fosters larger production.

TABLE V*

KINDS OF STEEL PRODUCED IN ILLINOIS, INDIANA, AND U. S. A. 1880-1923

(Tons)

	Illinois			Indiana			U. S. A.		
	Open Hearth	Bessemer	Crucible and Electric, etc.	Open Hearth	Bessemer	Crucible and Electric, etc.	Open Hearth	Bessemer	Crucible and Electric, etc.
1923.......	2,458,214	1,053,695	56,955	4,328,490	137,148	5,134	36,124,153	7,937,386	459,885
1921.......	1,057,860	531,218	10,127	2,311,793	34,621	2,112	15,188,253	3,947,981	143,248
1919.......	1,661,073	901,010	50,121	3,121,344	9,261	3,035	26,726,036	6,946,939	354,004
1914.......	891,336	867,804	11,613	1,662,441	......	398	17,081,375	6,219,304	103,278
1909.......	1,020,208	1,631,164	15,671	779,598	......	180	14,228,377	9,180,133	114,689
1904.......	361,650	1,193,548	......	80,799	......	.....	5,820,397	7,768,915	80,059
1899.......	249,313	1,211,115	282	51,953	......	14	3,044,356	7,532,028	104,393
1890.......	2,081	777,478	397	893	......	223	480,035	3,617,198	73,882
1880.......	825	226,352	116	....	......	.....	75,269	879,650	68,037

*Compiled from *U. S. Census Reports.*

Most of the steel leaves the mills in a finished or partly finished form. The ingots in all cases are rolled into commercial sizes, such as billets, sheets, blooms, bars. These serve as the raw material for a large number of steel-fabricating industries, which are scattered over the region which is served by the Calumet mills. The bulk of the steel, however, is converted into "forms and shapes" before it leaves the mill. Consequently, every steel plant has a more or less complete rolling establishment attached to it, to which the white-hot ingots are taken as soon as they leave the moulds. There they are rolled and cut to size, and transferred to the finishing mills which roll them into rails, shapes, structural steel, bars, plates, sheets, tubes, etc. In most cases, these are finished products, ready for immediate use. In some cases, they pass on to other departments for finishing processes, such as tin plating, or galvanizing. Generally all these processes are carried out in the same plant.

Modern equipment permits the manufacture of a wide variety of different shapes with the same machinery, since it is a relatively simple matter to change the rolls, and, therefore, the form of the product. Thus, for example, a rolling mill may produce rails in the morning and structural shapes in the afternoon of the same day.

The percentage of electric and crucible steel which is made in the Calumet District is very small. The product is both high in quality and in price, and its use is limited to certain industries which specialize in the highest grades of steel for special tools and scientific apparatus. The bulk of the electric steel is produced by the Illinois Steel Corporation. The small size of this particular phase of the steel industry makes it suitable for location where there is a steady local demand for that particular type of product. In this way, transportation costs are reduced to a minimum. Such plants exist in a number of the urban centers, and especially within Chicago. New York and other great eastern centers figure much more prominently in this phase of the steel industry than does the Calumet District. It is impossible, from the available data, to obtain detailed figures of the production of iron and steel by individual plants in Illinois and Indiana. Consequently, the tonnage of the various types of products in the Calumet District cannot be stated, even approximately. Hence, the discussion has been limited throughout to the broad facts which could be deduced from the available material. The plants of the Illinois Steel Com-

pany and the Indiana Steel Company produce practically every form of steel and every type of steel product. Their specialties consist of steel rails, plates, shapes, and bars. The Wisconsin Steel Company, as already noted, is a subsidiary of the International Harvester Company, and specializes in the production of steel for use in the manufacture of agricultural implements. Any surplus is utilized by other fabricating plants of a similar character. The Interstate Steel Company is mainly interested in serving its own plant which specializes in wire products. The Inland Steel Company produces a line of goods similar to that of the Illinois Steel Company, in which railroad equipment forms a large part. The Youngstown Sheet and Tube Company, as its name indicates, is primarily interested in the production of lap weld and butt weld tubes, of which it produces nearly 400,000 tons annually. The surplus steel is rolled into plates and sheets.

sources of supply. Approximately 75% of the ore used in the Calumet District comes from these more recently worked ranges,

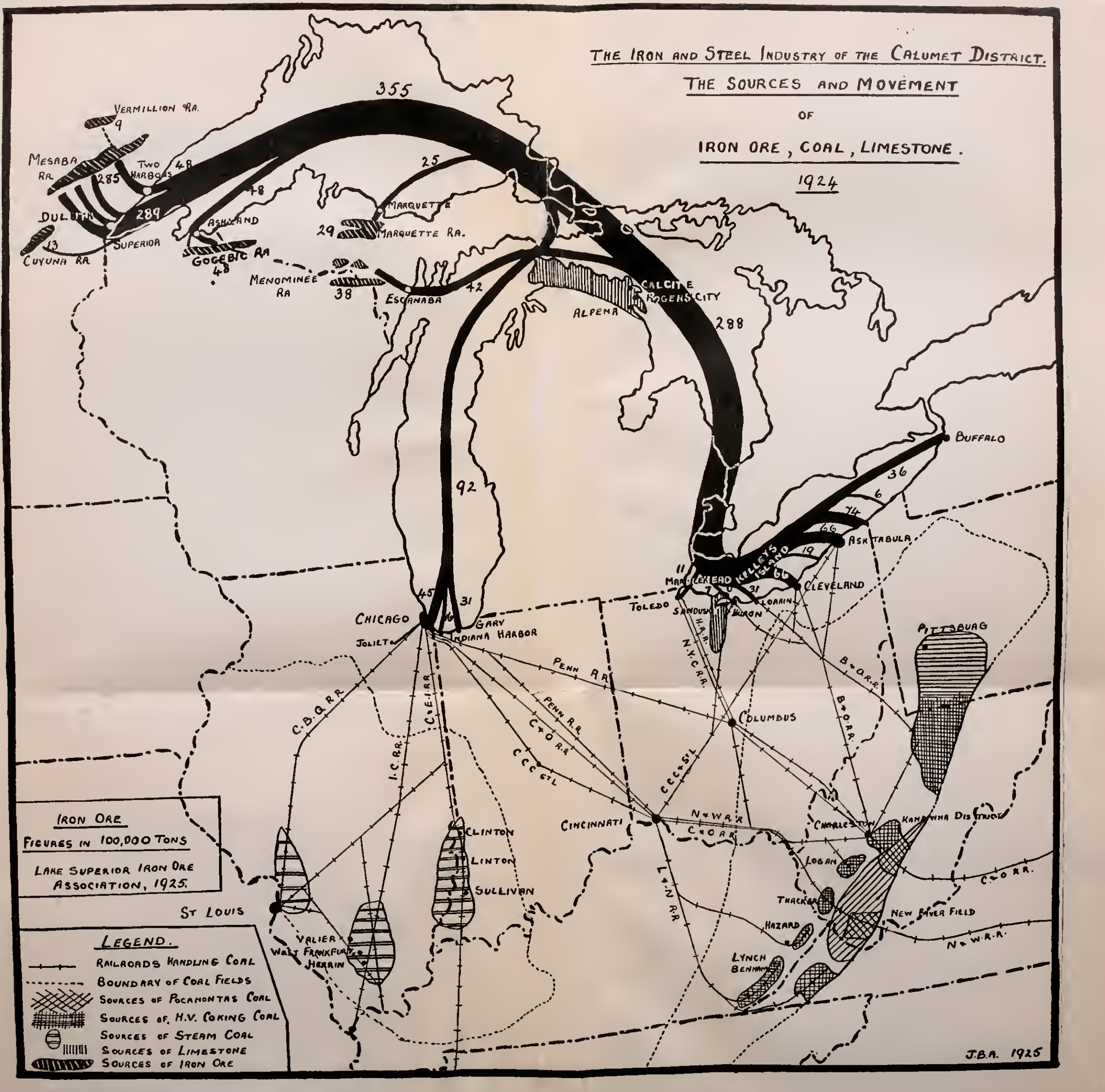

THE IRON AND STEEL INDUSTRY OF THE CALUMET DISTRICT.
THE SOURCES AND MOVEMENT
OF
IRON ORE, COAL, LIMESTONE.
1924
VERMILLION RA.
MESABA RA.
TWO HARBORS
DULUTH
SUPERIOR
CUYUNA RA.
ASHLAND
GOGEBIC RA
MENOMINEE RA
ESCANABA
MARQUETTE
MARQUETTE RA.
CALCITE
ROGERS CITY
ALPENA
BUFFALO
ASHTABULA
KELLEYS ISLAND
CLEVELAND
TOLEDO
SANDUSKY
LORAIN
CHICAGO
JOLIET
GARY
INDIANA HARBOR
PENN R.R.
C.B.Q.R.R.
I.C.R.R.
C.E.I.R.R.
C+O R.R.
C.C.C. STL
C.C.C. & STL
N.Y.C.R.R.
B+O.R.R.
COLUMBUS
PITTSBURG
CINCINNATI
N+W.R.R.
C+O R.R.
L+N R.R.
CHARLESTON
KANAWHA DISTRICT
LOGAN
THACKER
HAZARD
NEW RIVER FIELD
LYNCH
BENHAM
CLINTON
LINTON
SULLIVAN
ST LOUIS
VALIER
WEST FRANKFORT
HERRIN
IRON ORE
FIGURES IN 100,000 TONS
LAKE SUPERIOR IRON ORE ASSOCIATION, 1925.
LEGEND.
RAILROADS HANDLING COAL
BOUNDARY OF COAL FIELDS
SOURCES OF POCAHONTAS COAL
SOURCES OF H.V. COKING COAL
SOURCES OF STEAM COAL
SOURCES OF LIMESTONE
SOURCES OF IRON ORE
J.B.A. 1925
355
9
285
289
48
25
29
13
38
42
288
92
45
31
36
6
74
66
19
11

FIGURE 2

CHAPTER II

THE LOCATION OF THE CALUMET DISTRICT WITH REFERENCE TO AREAS FROM WHICH IT DRAWS RAW MATERIALS

The Calumet District is favorably situated with regard to supplies of raw materials. High grade ore, coal, and limestone can be assembled with relative ease at reasonable costs. All lake borne materials can be unloaded from boats directly on to the docks of the steel plants. In respect to iron ore, the Calumet producers have an advantage over those of inland centers in the Pittsburgh District who are obliged to transport their supplies a considerable distance by rail from Lake Erie ports.

Iron Ore

Consumption and Sources.—The Calumet District obtained over 9,000,000 tons of iron ore from the Lake Superior region in 1924. The mines, in the six rather widely separated fields, are relatively short distances from the lake ports (Fig. 2). In the east is the Menominee field, which covers a wide area in Wisconsin and Michigan. To the north and west are the Marquette and Gogebic ranges. These three mining areas constitute what may be called the "hard ore" producers, because the ores found there are coarser and much harder than those found in the other areas. They are generally known as the "Old Ranges," since they were discovered and worked first. The ore from these ranges is shipped from Escanaba, Marquette, and Ashland, respectively. Mining operations are carried out mainly by underground methods, although there was some "open pit" mining until recent years.

More important as producers at the present time than the "Old Ranges" are the Mesaba, Cuyana, and Vermillion ranges, which lie to the west and northwest of Lake Superior. In these latter ranges the ores are of a fine, and more or less loamy texture. The bulk of the product is mined in open pits, and the ease with which a vast tonnage is obtained, together with the higher grade of most of the ore found there, has made these the most important sources of supply. Approximately 75% of the ore used in the Calumet District comes from these more recently worked ranges,

90% of which is obtained from the Mesaba Range alone. The bulk of this ore is shipped from Duluth, Superior, and Two Harbors.[1]

The Grading and Classification of Ores.—Ore is graded according to its composition and structure. The qualities especially desired are a high iron content, and a low percentage of phosphorus and of water. The price is based on a theoretical ore which has a definite percentage of each of these constituents.[2] Ores are first classified into Bessemer or Non-Bessemer; the former, if they contain less than 0.001% of phosphorus per 1% of iron, the latter, if they contain more than that amount. The Bessemer ores command the higher price because they are the purest ores known.[3] This division is made because in the Bessemer process no phosphorus can be eliminated. Hence the pig iron from which the steel is made must have no more phosphorus than will maintain the Bessemer limits of 0.1% phosphorus in the steel.[4] Ores are further classified by source. They are either Mesaba or Old Range. The structure of the two types of ore is different, and each acts differently in the furnace. Many smelters do not care to use 100% Mesaba, since, owing to its fine texture, it is apt to pack down in the furnace and prevent the free circulation of the blast. Gas pockets sometimes are formed which are liable to explode. Consequently a mixture of Mesaba and Old Range ores is used in many mills in order to increase the spaces through which the air can circulate. One large producer in the Calumet District uses 85% Mesaba and 15% hard ore for this reason. On the other hand, many smelters

[1](a) For full discussion of the Lake Superior iron ores, see Crowell and Murray, *The Iron Ores of Lake Superior* (1923).

(b) For movement of ore, see Fig. II.

[2]Popplewell, F., *Iron and Steel Production of America*, p. 52.

[3]*Iron Age*, April 10, 1924, p. 1100.

ORE PRICES 1919-24

Year	*Old Range Bessemer per ton*	*Mesaba Bessemer*	*Old Range Non-B.*	*Mesaba Non-B.*
1919	$6.45	$6.20	$5.70	$5.55
1920	7.45	7.20	6.70	6.55
1921	6.45	6.20	5.70	5.55
1922	5.95	5.70	5.20	5.05
1923	6.45	6.20	5.70	5.55
1924	5.65	5.40	4.90	4.75

[4]Quarrie, B. D., "Operation of Blast Furnaces," in *Iron Ores of Lake Superior* (1923), p. 118.

use 100% Mesaba. These claim that if a hard "chunky" coke is used in conjunction with hard limestone, there is no irregularity in the operation of the furnace. Both procedures are followed in the Calumet District.

In recent years, there has been a very marked decrease in the proportion of Bessemer ores shipped. In 1902, 59.9% of all ore shipped was Bessemer, but in 1922 the percentage was only 29.5. This decrease is particularly noticeable in the movement of the Mesaba ores, where the amount of Bessemer has decreased from 80.7% in 1902, to 31.5% in 1922. This decrease is not only relative, but actual, for the total movement in 1922 was the lowest on record.[5] This is obvious in the Calumet District where the production of Open Hearth steel has increased enormously in the past decade, while that of Bessemer has decreased.[6]

The successful operation of a blast furnace calls for an accurate knowledge of the ores which are being used. They must be charged into the furnace with the proper proportions of limestone and coke in order that the impurities will flux properly and produce the desired grade of iron. The proportions of fluxing materials and fuel vary according to the composition of the ore. Therefore the ore must comply with its specifications. If it varies from the guaranteed analysis, the furnace manager is obliged to make troublesome changes. He has to increase or decrease the amounts of coke or limestone in the charge, raise or lower the temperature of the blast, and even then he may not be able to make the desired grade of pig iron. In the case of a plant devoted exclusively to pig iron this would be a serious matter, since the iron has to satisfy rigid chemical analyses to fit it for particular uses.

The average iron content of ore shipped from the Lake Superior Region in 1922 and 1923 was 51.83%, as against an average of 51.42% in 1914 and 1915. In 1902, it was 56.22%. These figures show there has been a considerable decrease in the iron content during the past twenty years. The lowest level was reached in 1916; since that time there has been a slight increase. There appear to be three factors which determine the average grade of

[5]Crowell and Murray, *Iron Ores of Lake Superior* (1923), pp. 80-81.

[6]Ref., Table V, which shows the production of steel by kinds for a period of years.

ore mined and marketed. (1) During periods of business depression, iron production is low and the prices of ore accordingly fall. During such a time, only high grade ore is used. The opposite is true for boom periods, when smelters will take almost any ore they can get, since prices are high. Consequently, the average grade falls. (2) When a new body of high grade ore is opened up, the effect is to raise for a time the average grade marketed. In 1893, the heavy shipments of Mesaba ore raised the average for that year to the highest point ever reached, 61%. (3) In general, the best and most accessible ores are exploited first. Within a few years, these are either exhausted or cannot longer supply the demand, in which case the production of lower grade ores is consequently increased and the average grade is reduced.[7] The general improvement in the grade which has been noticeable in the last few years is due largely to the better methods of marketing the ore, together with beneficiation, mainly washing, which is being practised on an increasing scale at the mines.

Low grade ore increases the costs of production. If the demand for iron remains about the same as at present, or increases, this in turn will necessitate a considerably increased consumption of ore, limestone, and coke. This in its turn will increase labor and furnace costs, while the output of iron and steel per day will be decreased, since the capacity of a furnace is limited. Consequently, the prices of pig iron will rise. "A decrease of 5% in the iron content of ore involves the additional use of about 0.14 tons of ore, 0.12 tons of coke and 0.36 tons of fluxing stone per ton of pig iron produced . . . which at present prices would mean an increase in raw materials alone of about $1.25 per ton of pig iron."[8] The ore is analyzed immediately it arrives at the furnace and this "natural analysis" forms the guide in calculating the "burden" for a blast furnace. The "dry analysis" made at the mine is useless for this purpose since the ore collects moisture as a result of exposure on the stock piles. This "dry analysis" gives, however, an accurate knowledge of the chemical composition, which serves as the guide for blending, and determining the quantities of coal and coke necessary for the reduction of the particular mixture.

[7]Eckel, E. C., *Iron Ores*, pp. 358-361.
[8]*Ibid.*, p. 363.

The question of the grade of ore is vital to the Calumet smelters since this determines the amounts of fuel and limestone which must be used, in the costs of which the district is at a disadvantage compared with Pittsburgh. The steel companies have acquired properties which contain large reserves of high grade ore. The possession of these ores ensures them an adequate supply for many years. They constitute an important reason for the amalgamations which have taken place, and which are probable in the future. Consequently, the larger corporations, with their abundant reserves, are more secure than the smaller companies, which purchase their ore on the open market. Ores so purchased will become increasingly expensive as the supplies of independently owned reserves approach exhaustion.

Mining Operations.—Mining operations in the Lake Superior region are among the more highly organized industrial activities in the country. They have been developed to cope with the demands of the iron and steel industry, which have increased so rapidly in the last few decades. The size of the operations, the enormous tonnage produced, the comparatively short navigation season of about seven months, and the needs for standardized grades, all have combined to necessitate a high degree of efficiency. Large mining corporations predominate. These are either independents or subsidiaries of the steel companies, but the aims and problems of each are the same.

Two types of mining operations have been developed to suit the particular conditions in the six producing fields. The hard ores of the Old Ranges are produced mainly by deep under-ground methods, while on the Mesaba, Vermillion, and Cuyana Ranges, the bulk of the ore is obtained by open pit methods. Of the two, the latter is by far the most productive and least costly. The soft ores of these ranges can be excavated with steam shovels at a very low cost (Plate 1). A large daily output is readily obtained, yet, at the same time, production is very elastic and can be adjusted easily to suit the conditions of the market. In periods of depression, operations can be stopped indefinitely without incurring the excessive charges for maintenance that obtain in underground mines. Labor costs are less, since fewer skilled men are required. Because working conditions are less cramped, mining equipment can be of the largest type. This facilitates large scale production and extensive economies in operation. The choice of one or the

other of these methods depends upon (1) the thickness and character of the overburden, (2) the size, shape, and uniformity of the ore body, (3) the facilities for approaching the ore by open cuts, (4) the availability of adequate space for the dumping of the top burden, and (5) the amount of capital which is available for stripping operations.

Underground methods are practised systematically where they form the most suitable means of tapping the ore. The one-time wasteful mining operations have been replaced by systematic exploitation which ensures a high percentage recovery of ore, with a minimum of risk of damage from cave-ins, accidents, and flooding. The standard method employed is to sink a main shaft outside, but near, the ore body. At intervals of one hundred feet, main drifts are opened to the limit of the ore, or to the boundary of the property. From these, "raisers" are put up to sub-levels. Ore removal starts from the top and proceeds downwards. The ore is dumped into the raisers and loaded by gravity into trucks in the main drifts, along which it is transported by trolleys to the shaft. As each successive level is worked out, the roof is allowed to cave in. This method ensures a high recovery of ore at a moderate cost. These operations can be carried on all the year round, for the ore obtained after the close of the navigation season is dumped in stock piles ready for the resumption of shipments in spring. Open pit mining, in contrast, commonly is suspended during a part of the winter because of deep snow and low temperatures.

The movement of the ore to the docks and into the boats represents a triumph of organization and skill. The assembling of such a vast tonnage of ore on the docks is no simple matter. Boats of varying capacity arrive for cargoes of definite grades, which must be strictly up to specifications. The shippers know approximately when a vessel is due, and the nature of its next cargo. They aim to have the exact quantity and quality ready before it arrives, so that loading can be completed without any delay. In order to do this, the docks are divided into "blocks," each of which contains a definite weight of a particular grade. The organization behind all this extends back to the mines. When the ore is loaded there, samples are taken representative of every ten cars. An analysis is made immediately and the contents of iron, manganese, silica, and phosphorus checked. The numbers of the cars containing this specific consignment are recorded after

the train is made up, and by the time this reaches the switching yard adjacent to the docks, the instructions for dealing with it are issued. At the docks, every cargo which is to be made up has been given a definite block number. When the consignments of ore arrive, they are accurately weighed and the necessary quantities which are required to make up a definite mixture are dispatched to the different blocks. Should any of the latter be short on their particular blend, there are always on hand reserves of "on grade" ore which can be used to make up the requirement. If any block contains a surplus, then what remains is renumbered and used later to make up a new cargo, care being taken that the average grade for the whole block analyzes to the new specifications.

During the navigation season, the ore trains arrive on the docks at half hour intervals, and, consequently, the whole operations are carried out with remarkable rapidity as well as accuracy. Eleven railroad companies serve the ore docks, most of which they own. In addition to hauling the heavy tonnage of ore, they are responsible to the mining companies for making and maintaining certain ore grades which have a rigid analysis. The railroads are expected to handle the ore promptly, and to load it into the holds of lake freighters, each of which carries 5,000 to 14,000 tons.[9]

Ore Handling at Upper Lake Ports.—The ore docks are as highly specialized as the freighters, and since 1862, when the "spout" loading system was first installed at Marquette, they have developed both in size and efficiency in keeping with the improvement and specialization of the lake boats. The old wheel-barrow method of loading was far too slow and expensive, and it gave way to the more rapid, and cheaper, gravity system.

At first, and this still holds good at some of the shipping points, the docks were built of timber. In recent years, however, steel and concrete have been employed more and more in their construction. Apart from being stronger, these materials obviate the fire hazard. With the increasing size of boats, the docks have been built higher and higher so that loading could continue to function entirely by gravity. Formerly, the bases of the pockets were barely twenty feet above the water, but now they average more than forty feet. All of the docks have developed consider-

[9]Barneveld, C. E. van, *Iron Mining in Minnesota*, p. 208.

able storage capacity, owing to the increase in the number of pockets.

The saving, both of time and of costs, as a result of this efficient organization, is considerable. In 1909, the L.S."W. E. Cory" loaded 10,111 gross tons of ore at Two Harbors in 39 minutes. In 1911, the same vessel loaded 9,457 tons in 25 minutes at Allouez Dock, Superior. Such rapidity of loading enables each ship to increase the number of voyages it can make in a season and thereby to increase its earning capacity.[10]

The cost of assembling the ore at these docks varies according to the rail haul and the dock charge. The latter is 10 cents at Marquette, Escanaba, and Ashland, but is only 5 cents at Superior, Duluth, and Two Harbors. The rail freights from the Marquette Range to Marquette average 63 cents per ton, and to Escanaba, 81 cents; from the Menominee Range to Escanaba, 81 cents; from the Gogebic Range to Ashland, 81 cents; from Mesaba and Cuyana Ranges to Superior, Duluth, and Two Harbors, 86 cents; from the Vermillion Range to Two Harbors, 86 cents. Lake transportation costs are the same to all Lower Lake ports, with the exception of those from Escanaba to the Calumet ports, which are slightly less than to Erie ports. These vary according to the port of origin from 65 cents to 83 cents per ton. The average unloading cost is 10 cents per ton.[11]

Reserves of Ore.—Since the Calumet District is entirely dependent upon the iron ores of the Lake Superior region, the question of reserves there is of vital interest to its steel producers.

Various computations have been made, varying from that of Hayes in 1908, who put the total amount of merchantable ore at 3,510,000,000 tons, to that of the Michigan Tax Commission, in 1909, of 1,584,000,000 tons. The first is probably an overestimate while the latter seems an underestimate, considering the purpose for which it was made. Eckel suggests that the probable reserves amount to about 2,500,000,000 tons, and certainly to more than 2,000,000,000 tons.[12] From these figures it would seem that the Calumet District, and the other iron and steel districts

[10]Backert, A. O., *A. B. C. of Iron and Steel*, p. 44.

[11]Crowell and Murray, *Iron Ores of Lake Superior* (1923), pp. 91-93.

[12]Eckel, E. C., *Iron Ores*, pp. 384-89.

as well, are assured of adequate supplies for many years to come. The problem arises, however, as to how much of this reserve is worth mining under present conditions. According to R. C. Allen (State Geologist of Michigan), in a paper read before the American Institute of Mining and Metallurgical Engineers and the Cleveland Engineering Society, much of this so-called reserve is not iron ore at all, because according to his definition "Iron ore is rock which can be moved from its natural position in the earth and used in the manufacture of iron with profit." He states that it would be unlikely that mining operations would be carried on in the Superior region after all the ore above 35% iron content had been removed, because the movement to the present smelting areas would not be worth while, from the point of view of iron produced in proportion to slag. He is of the opinion that the mining industry will migrate back to the East, where higher grades of ore than 40% are known to exist. If he is right, then the life of the iron and steel industries of the Calumet District depends upon the reserves of Lake Superior ore of a higher grade than 35%.[13] One thing is certain, and that is the total dependency of the Calumet District upon the Lake Superior iron ores. Furthermore, anything which increases the cost of smelting, will affect this area adversely. The better the grade of ore, and the greater the production per ton of ore used, the more easily can this district compete with other districts which have local supplies of fuel.

Lake Transportation Facilities.—Cheap transportation on the Great Lakes has been one of the more important factors in the development of the iron and steel industry of the United States, and particularly of the Calumet District. It is doubtful if the industry would exist at all in the Northern Interior if the Lakes were not there. It would be impracticable to assemble the Superior iron ore at the various smelting centers in any other way. No one railroad, however well organized, could possibly handle it. The lake freighter has been evolved to cope with this bulk traffic.

Owing to climatic conditions the navigation season on the lakes is restricted, as already noted, to a little more than seven months, during which time the steel mills must receive a supply of ore for twelve months. Failing this, they would either have to close down during part of the winter or obtain additional

[13] Crowell and Murray, *op. cit.*, (1923), pp. 108-10.

supplies by rail. Consequently, by December 1st the seasonal movement must be complete. This date is fixed quite as much by the insurance companies as by the weather conditions, since thereafter, the risks are too great to be assumed at normal rates by the insurance companies. Under favorable weather conditions special policies are issued for a period of about two weeks at double the ordinary rates.

As a result of these limitations to navigation, it has been advantageous to devise boats and handling facilities which will expedite to the utmost the movement of the ore. The modern lake freighters are designed to carry bulk cargoes only. They are nothing more than great steel boxes. They are unlike most ocean vessels, in that the engines are placed aft instead of amidships, while the navigating bridge is forward. There is only one deck, and all the cargo is stowed in one long hold which extends the whole length of the boat between the engines and the bridge. The majority of the vessels which have been built since 1905 have been from 524 to 600 feet long with an average cargo capacity of 10,000 tons (Plate 2). Although the size of these boats has been increased enormously of late years, their engine units have remained small. Compared with many steamers they are very low powered, but their small coal consumption—an average of 55/100 ounces of coal per ton mile of cargo carried—makes them very economical to run, and freight charges, consequently, are kept low. The most modern types are 600 feet long, with a beam of 60 feet, and 32 feet depth of hold. These have a rated carrying capacity of 12,000 tons, but they actually carry as much as 14,000 tons on a draft of 21 feet.[14] A number of larger ore vessels exist, as for example the L.S. "W. Grant Mordan," which is 625 feet long, 59 feet breadth of beam, and 33 feet depth of hold, with a a rated carrying capacity of 14,000 tons.[15] There probably are no more efficient bulk carriers in the world, and it is recognized that the "600-30-32" class is the most efficient type of ore and coal carrier that exists.[16]

The design and size of the boats have been influenced by two factors, the depth of the channels between the Lakes and the methods adopted in loading and unloading ore.

[14]*International Shipmasters Association Directory*, 1923.

[15]*Mining and Metallurgy*, Nov., 1921, p. 11.

[16]Lake Carriers Association, *Annual Report* (1922), p. 116.

These vessels have no fixed routes. They are employed in all the Great Lakes with the exception of Ontario. Consequently, their size is limited by the capacity of the Soo Canals, and of the St. Mary and St. Clair rivers. With each successive deepening of these critical waterways, the size of the boats was increased accordingly. It is interesting to note that the first consignment of ore to Lake Erie in 1853, 152 tons, was portaged around the rapids of the Soo, while the first shipment through the Soo Canal in 1855 was 132 tons. It was not until 1884 that there was a 16 foot channel throughout. The increased cargoes which could be carried so cheapened the costs of transportation, that, in 1884, freight rates were only $1.21 per ton, compared with $4.14 per ton in 1866. Meanwhile, boats had increased in size from 600 tons to 1900 tons.[17] The demand for greater depth in order to permit the use of larger vessels induced the Federal Government to rebuild the old 1885 locks at the Soo. The new structure, the Poe Lock, provided 20 feet draft, and at the same time, 1896, the channel through the St. Mary River was improved and shortened by 11 miles, and provision was made for the first time for night navigation.[18]

In 1895, the construction of the steamers was modified to suit the construction of the ore docks, which were designed to load ore by gravity through spouts from hoppers. These spouts were placed at intervals of 12 feet (Plate 3). In the new steamers, the hold was made accessible through a large number of hatches which opened on to the deck. These were placed 24 feet apart "from center to center fore and aft." It was soon seen that these hatches did not utilize the loading capacity of a dock to the best advantage, since only alternate spouts could be used at one time, and the boat had to be moved 12 feet in order to use the others. Consequently, in 1902, the first boat appeared with its hatches spaced the same distance apart as the spouts. As a result of this change, loading operations could be completed in less than half the time previously taken, since all the spouts throughout the length of the boat could be used at one time without moving the boat. This also effected a considerable saving in costs. This first boat of the newer type loaded her first cargo of 5,250 tons in 30½ minutes. Since that time all the new boats have been constructed

[17]Crowell and Murray, *Iron Ores of Lake Superior* (1923), p. 91.
[18]Backert, A. O., *The A. B. C. of Iron and Steel*, p. 44.

to provide similar accessibility. The time spent in loading has been steadily reduced. The L.S."W. E. Cory" loaded 10,111 tons gross in 39 minutes at Two Harbors in 1909.[19] This change in deck structure necessitated modifications in the construction of the hold in order to eliminate certain obstructions which particularly affected unloading operations. The reduction in the time taken to load, together with that saved in unloading, enabled a boat to make several more trips per season—a distinct advantage in any transportation organization, and especially important on the Great Lakes, with their relatively short navigation season.

As a result of these improvements, freight rates have steadily decreased, and, in 1922, they averaged 90 cents per ton.[20] The difference in costs between boat and rail transportation is very considerable. This is true in all commercial movements on the Great Lakes and the oceans, but it is particularly significant in the case of the movement of bulk commodities on the Lakes. "There is no doubt that the Lake freighters provide the cheapest means of transportation in the world. Their charge per ton mile is 0.07 cents, as compared with one cent by rail. Economical and efficient transportation lies at the foundation of industrial development. . . . The bringing together of the cheap coal of Pennsylvania and the cheap rich iron of the Mesaba range has been made commercially practicable by the cheapness of water transportation."[21]

The carrying trade on the lakes is chiefly in the hands of large corporations who controlled 60% of the total number of ships, but 96.3% of the tonnage, in 1916. These figures show that they also own and operate the larger vessels.[22] Ownership by individuals and by small independent companies began to decline after 1907, when the Rockefeller interests put a fleet of twelve vessels into operation. At the present time, the United States Steel Corporation, through its subsidiary, the Pittsburgh Steamship Company, controls a large fleet, but these form only a part of the number necessary to handle 60,000,000 tons of ore in seven

[19]Backert, A. O., *op. cit.*, pp. 44-47.

[20]Crowell and Murray, *Iron Ores of Lake Superior* (1923), p. 91.

[21](a) *Mining and Metallurgy*, November, 1921, p. 13.

(b) West Virginia and eastern Kentucky supply most of the coking coal which is used in the Calumet District.

[22]*Dept. of Commerce Report*, 1916.

months, not to mention the grain, coal, and limestone traffic. In the spring it is customary for the iron and steel companies to contract for the conveyance of a given quantity of ore which they will need for the ensuing year in excess of what their own boats can carry. In 1923, the rate averaged 80 cents per ton from the Upper Lake ports to all those on the lower lakes. These contract rates vary slightly from year to year, and the grain movement competes with that of iron ore. Should any smelter need tonnage in excess of that for which he has contracted, he must enter the open market and take what he can get at the prevailing rate. This "Wild Rate" may be higher or lower than his contract rate was, according to the supply of shipping available at the time.

Facilities at Calumet Ports for the Reception of Ore.—The use of these lake-shipping facilities already noted is dependent upon the availability of adequate harbors for the reception of water-borne materials. In every instance the provision of these facilities in the Calumet District has been initiated, if not entirely provided, by the steel interests themselves, since prior to 1880 there were very meager harbor facilities there. The improvement of the mouth of the Calumet River and the construction of an outer harbor were followed immediately by the deepening and straightening of the river itself (Plate 4). The three improvements were undertaken with the aim of making the industrial sites adjacent to the river accessible to lake steamers. Eastward from Calumet Harbor stretched a desolate, dune fringed shore devoid of any form of harbor. It was not until 1901 that any project was conceived for the construction of Indiana Harbor and this was not completed until 1906. The harbor at Gary was constructed soon afterwards.

This harbor development was made relatively simple by the nature of the shore. The shallow water facilitated the building of piers and breakwaters. The loose sand and glacial till, which covers most of the area, made excavation easy. The necessary material for filling could be sucked up from the lake floor with relative ease. The Calumet River formed the natural place to begin operations, since, as already noted, the pioneer plant was located there, and the river and its mouth formed the nucleus of a harbor. Hence harbor construction in the Calumet District began with the deepening of the mouth of the river and the improvement of the only waterway which led inland. It was the

urgent need for facilities to receive the lake boats bringing ore to the steel mills which was responsible for the initial steps, while the need for additional furnace sites called for the harbor improvements which were undertaken at Gary and Indiana Harbor.

Through these three ports pass all the iron ore, most of the limestone, and much of the coal, consumed by the Calumet furnaces.

At present Calumet Harbor is the most important of the three since it handles the largest share of the total trade. Originally, there was no outer harbor there. Moreover, only very small boats could enter the river, since its mouth was blocked by a long sand spit which had been built by the littoral lake currents, winds, and deposition by the river itself. This spit had forced the river to make a sharp bend just before reaching the lake, and to run parallel to the shore for about 3200 feet. The channel across the bar at the mouth of the deflected river averaged 100 feet in width, but its depth, always inadequate, varied according to the season. In spring when the river was swollen from rains it was able to scour a slightly deeper channel, the depth of which ranged from two feet to four feet. Inside the bar, there was a depth of thirteen feet for a distance of four miles upstream. In the 1870's a channel was dredged across the base of the spit that permitted the lake boats of that period to enter the river and to serve the early iron and steel plants which were established along the lower banks in the 1880's. Since 1884, dredging has kept pace with the increasing size of the lake freighters.[23] The outer harbor, and the improved river channel, five miles in length, constitute one extended harbor which is accessible to the largest lake freighters at all times during the navigation season. The outer harbor, completed in 1911, covers half a square mile, and is simply the dredged portion of the lake which is enclosed by the piers and the breakwater. It protects the entrance to the river, as well as the north slip, which the Illinois Steel Company constructed to permit ore boats to discharge directly on to its store piles. The outlet is on the down-lake side in order to prevent it from being silted up by the action of the lake currents from the north-northwest. The river has been dredged for a distance of five miles to a depth of 22 feet. Except in the rock section located between 111th and 114th Streets, this dredging

[23] *Survey of the Northern and Western Lakes*, Bull. No. 31 (1922), pp. 205-6.

was a simple matter, since elsewhere the river bottom was mud and silt. In the rock section, where bedrock was encountered at about eighteen feet, the requisite depth was obtained by blasting. The navigable channel averages 200 feet in width, but there are considerable variations. North of the Elgin Joliet and Eastern Railroad bridge, it is 300 feet wide. In the neighborhood of the Federal Furnace plant, it is only 60 feet across. Beyond the Interstate Iron and Steel plant, the channel decreases in depth rapidly and becomes narrower. The bulk of the traffic, however, is to be found below the Interstate Iron and Steel plant, where, as already noted, the channel has a depth of 22 feet.

No trouble is experienced in bringing in even the largest lake steamers under their own power, and the arrival of 14,000-ton cargoes of coal and ore is not an uncommon occurrence. Some captains, however, prefer to utilize the tug service in order to avoid any chance of running aground. In order to permit the larger ships to turn around there are three turning basins of ample size.[24]

Nine slips have been constructed on the west side of the river to provide dock space for the industrial plants which are located there, a number of which are engaged in manufacturing iron and steel. These slips are by no means fully utilized, as much land along the river front remains undeveloped. Some of this is held by land companies, or by individuals for speculative purposes. Some of it is held by industrials themselves to provide for their own future expansion. Much of it has been so subdivided among a number of owners that doubtless it will become increasingly difficult to obtain large industrial sites there in the future. This may have a retarding effect on the progress of the district.

Free navigation on the river is not impeded by many bridges. Street traffic in this industrial section is not very great when compared with that of central Chicago. Consequently, three bridges handle it with apparent ease, as compared with twenty-one on the Chicago River system. Four railroads cross the Calumet River in its lower course, but river navigation has the right of way at all times. The only apparent drawback results from the location of three of these railroad bridges in close proximity one to another. All have narrow draw openings and the lack of more

[24] *Survey of the Northern and Western Lakes*, Bull. No. 31 (1922), pp. 206-7.

space renders it somewhat difficult to handle the large freighters in the most used part of the river.[25]

But for these Calumet River improvements there could not have been any development of upstream steel plants, for modern lake carriers could not have reached them. As it is, these plants have been able to compete on favorable terms with those located at the mouth of the river or along the shore, and "Their development has kept pace with the progressive deepening of the river."[26]

The utilization of the lake front for industrial and commercial purposes is encouraged by the laws of Indiana.[27] This has been, therefore, an incentive for the construction of harbors along that shore, eastwards from South Chicago. Two have been constructed already, and at least two others are probable. The Buffington Portland Cement Company is planning one at its present site, and the Inland Steel Company probably will construct one when it develops its property east of the Gary Sheet and Tube Mills.

When the Inland Steel Company decided to locate in this district the considerations which led to the choice of the actual site were proximity to Chicago, at a point where either a deep water harbor existed, or where such a harbor could be constructed easily. The only suitable sites around Calumet Harbor already were occupied, and the remaining shore in Cook County, east of South Chicago, had been either subdivided or dedicated to park purposes, and location there accordingly was impossible.[28] Consequently, the problem resolved itself into one of providing an artificial harbor somewhere along the Lake County shore of Indiana. The nearest available site to Chicago was found where Indiana Harbor is now. Accordingly, in 1901, the project was launched, and private funds were utilized to construct the harbor in 1906.

As first constructed, the channel (17 feet deep) which constituted the outer harbor, was enclosed by wharves and piers

[25] *U. S. Engineer's Report*, "Chicago and Adjacent Waterways" (1913), p. 123.

[26] *House Doc. 234*, 63rd Congress, 1st Session (1913), p. 29.

[27] *House Doc. 237*, 63rd Congress, 1st Session (1913), p. 30.

[28] *House Doc. 237*, *loc. cit.*

300 feet apart, which extended in a northeasterly direction from the first railroad bridge, about 550 feet inside the earlier shore line. The piers were made to converge towards the lake so that the entrance was only 140 feet wide. The construction of this channel, like the dredging of the Calumet River, was easy, since it also was excavated in loose sand and glacial material, and the spoils were utilized for filling purposes on either side. In order to make this harbor accessible from the lake with a minimum amount of dredging, a channel was made across the eastern end of the Indiana Shoal which, at this point, extends parallel to the shore.[29] The development of the surrounding area soon led to the demand for a public harbor at this point. Since private funds had been utilized to construct Indiana Harbor, it could only be used by its owners, the Inland Steel Company. With the growth of the oil industry at Whiting, and the need for public harbor facilities, the Federal Government was persuaded to take over the original harbor in 1910. Considerable improvements were then inaugurated.[30]

In 1915, a breakwater was commenced in order to protect the entrance, and to make it accessible in all weathers. This was completed in 1921. In 1916, the original harbor channel was extended lakewards between two areas of "potential fill." This lengthened the harbor channel to 3,200 feet. Part of the material which was excavated in the course of these dredging operations was used to form the nucleus of the present sites of the main plants of both the Inland Steel Company and the Youngstown Sheet and Tube Company. Only sufficient filling was done, however, to permit the erection of a blast furnace on each side. The remainder of the area has since been utilized as a dumping place for the slag produced, thus serving a double purpose. Land building has been associated with waste disposal in a very advantageous manner.[31] The present channel is 350 feet wide throughout its length, and has been deepened to 22 feet, thus making it possible to receive the largest lake freighters with ease. On either side of this channel are the steel plants, and both have their ore docks alongside. There is sufficient space in the channel to carry out unloading operations on both sides simultaneously, and yet leave

[29] *Survey of Northern and Western Lakes*, Bull. No. 31 (1922), p. 210.
[30] *U. S. Army Engineer's Annual Reports.*
[31] *Iron Age*, Jan. 16, 1908, pp. 207-8.

abundant room for other vessels to pass. Boats can enter and leave without the assistance of tugs.

The harbor channel is continued under the railroad bridges to the Inner Harbor, or what is generally called the Indiana Harbor Canal. This has a minimum depth, where completed, of 20 feet. It extends southwards for one and one-third miles, where a branch leads off towards Wolf Lake (Fig. 1). The main channel continues southwards to the Grand Calumet River two and one-half miles east of Hammond. When it is completed this canal will be 200 feet wide and 20 feet deep throughout its entire length. It is on the western arm of this canal that Jones and Laughlin propose to build their new steel plant. The Government only maintains those parts which have been completed to standard width and depth (200′ x 20′).[32] Dredging operations are now in progress west of Forsyth Avenue Bridge in that section to be occupied by Jones and Laughlin.

The Indiana Harbor Canal, when it is finished, will increase the area which will be accessible to lake freighters, and thereby increase the acreage of land which will be suitable for, and available for, the establishment of iron and steel mills. Sites in this area will have an advantage over those along the Calumet River in that canal navigation will be simpler than river navigation, owing to the fact that there is only one bend in the canal.

Gary harbor is privately owned as it was built by the United States Steel Corporation, through the medium of the Indiana Steel Company, in order to serve the steel plant which was built around it. Like Indiana Harbor it is a slip, excavated in the sandy shore (Plate 5). Prior to the building of this harbor, and the subsequent industrial and urban development nearby, this site was a wilderness of sand dunes and swamps. Construction of the harbor took place in 1906. It is enclosed by two piers, 250 feet apart, which extend 2,000 feet out into the lake. It is continued inland from the shoreline of 1906 for a distance of 3563 feet by a slip which terminates in a turning basin, located within 300 feet of the Grand Calumet River.[33] Boats originally entered the canal

[32] *Survey of Northern and Western Lakes*, Bull. No. 31 (1922), pp. 210-12.

[33] (a) *House Doc., 237*, 63rd Congress, 1st Session, p. 122.
(b) *U. S. Army Engineer's Annual Reports.*

slip direct from the lake, but, in stormy weather, this was dangerous. Hence, in 1911, a breakwater was constructed to protect it from northeasterly gales.[34] The Gary mills receive all their ore and limestone by way of this harbor, without which the whole development of the steel industry at Gary would have been impossible. The depth is 23 feet, which is more than adequate for the largest freighters on the lakes. The lake boats unload their cargoes of ore or limestone directly on the docks located along the west side of the slip, close to the twelve blast furnaces.

Calumet Harbor, Indiana Harbor, and Gary Harbor have been developed by and for the steel industry. Their distance from the business districts of Chicago has permitted them to develop along these specialized lines. Apart from the grain and oil, which are exported from Calumet Harbor and Indiana Harbor, respectively, the materials required for the blast furnaces constitute their sole traffic.

All the iron and steel companies are adequately supplied with docks and unloading equipment. Cargoes are handled promptly and rapidly. It is to the interest of a company to see that no time is lost. The more efficient the equipment, the more easily and satisfactorily can the steel company contract with the ship owners to handle its needed materials. The Government maintains the harbors at South Chicago and Indiana Harbor, but not at Gary. The individual steel companies provide the dock equipment in all three places. All the companies have modern apparatus, although there are considerable variations in the type and in the capacity. The latter depends upon the amount of material which has to be handled.

The modern methods of unloading these bulk cargoes, not only in the Calumet District, but also at other receiving ports around the lower lakes, represent a great achievement. Under present conditions the commodities are handled entirely by machinery, which although expensive to install, is, nevertheless, much cheaper in the long run than were the older methods. The need for speed, the great quantities of materials to be moved, and the cost of hand labor, have made this development necessary.

In 1862, the only known way to unload these vessels was to shovel the ore into buckets which were lowered into the hold of

[34] *Iron Age*, January 7, 1909, p. 2.

the vessel. These were then hoisted on deck and their contents dumped there ready to be loaded into wheelbarrows, and taken ashore. By this method it took four days to unload 300 tons, the average cargo at that time. It is difficult to imagine a 10,000 ton cargo from a thirty-three foot hold being unloaded in this fashion. The number of trips which a large boat would make during the navigation season under these conditions would be few indeed. The invention of a portable donkey engine to hoist the bucket reduced the time for unloading the average schooner by one day. By 1882, a rig for raising the bucket and conveying it to the storage pile on the dock was invented. It was not, however, until 1899, that Hulett invented an unloader with self-filling buckets. This reduced the time enormously. By 1902, a cargo of 5,250 tons of ore was unloaded in three hours and fifty-two minutes. The Brown unloader was put on the market soon after this, and for some years Hulett's and Brown's were in general use at all of the iron ore receiving ports. From these early types the modern, electric, automatic, and rapidly operated machines have been developed. The first electric Hulett was installed at Conneaut in 1912. The machines used in the Calumet District are all electrically operated, and they not only unload a ship with astonishing rapidity, but they also can convey the material to any part of the dock. They also are used to transfer ore to the hoppers from which it is fed to the skips and the furnaces. (Plate 6). Ore, coal, and limestone, can all be handled in this manner, and the saving in costs of handling is enormous, abundantly justifying the heavy expense of installation. "When vessels were unloaded by wheel-barrows it was estimated that it cost 50 cents per ton to unload them; when the first Brown hoisting and conveying machine was installed at the docks at Cleveland it was estimated that it had reduced the actual cost of unloading to 18 cents per ton."[35]

From the following details of the installations at the plants located in the Calumet District, it can be seen that they possess every modern convenience to facilitate the rapid unloading and handling of ore, coal, and limestone as inexpensively as possible. As a result of these improvements which have facilitated unloading operations, the costs have decreased to approximately 10 cents

[35]Backert, A. O., *The A. B. C. of Iron and Steel*, p. 48.

per ton. Less modern equipment would put the Calumet operators at a disadvantage compared with those at Lake Erie ports.

The Illinois Steel Company at South Chicago has two docks with a total storage capacity of ore and limestone of about 3,000,000 tons. At the north dock, its equipment can handle 12,000 tons in 10 hours, while at the south dock, 13,000 tons can be unloaded in the same time. This large capacity is required to handle the enormous tonnage of material which the company needs each year, and to ensure an ample winter stock being obtained during the seven months navigation season. The Iroquois plant is equipped with unloaders which can handle 10,000 tons in 12 hours. Those at the Wisconsin dock move 18,000 tons in 24 hours. The Federal Furnace Company has equipment to handle 10,000 tons in 18 hours. The largest equipment is to be found at Gary where 35,000 tons are unloaded in 20 hours (Plate 7). The amount handled there in a year is considerably more than 3,000,000 tons. The Inland Steel Company's equipment permits the unloading of 30,000 tons in 20 hours. The unloaders at the Youngstown Sheet and Tube plant handle 10,000 tons in 16 hours.[36]

The installation of so much expensive machinery has been necessary because of the bulk to be handled and the need for speed on account of the relatively short navigation season. In addition, the convenience of machine handling is very great, since it reduces the labor force which would otherwise be necessary.

Coal

The steel plants in the Calumet District are as intimately concerned with the supplies and sources of coal as they are with sources and supplies of iron ore. The available supplies of high grade coking coal are abundant. The pressing problem, however, results from the high cost entailed in transporting this coal from the producing areas. This has a marked influence on smelting practices.

Sources.—The Calumet smelters have two main sources of coal: (1) the Appalachian field, particularly those sections which are located in eastern Kentucky and West Virginia, and (2) the Illinois-Indiana portions of the Eastern Interior field.

[36]Crowell and Murray, *Iron Ores of Lake Superior* (1923), pp. 125-27 and personal observation.

These two sources provide special types of coal which are utilized in different ways (Fig. 2). The mines in eastern Kentucky and West Virginia produce two main grades, high volatile and low volatile, both of which are particularly good for coking purposes, either individually or in conjunction with one another. The district producing high volatile coal lies in the extreme southern part of West Virginia and adjacent parts of eastern Kentucky and Virginia. The main producing mines in West Virginia are located in the Logan, Kanawha, and Konova-Thacker Districts, and these produce about 24,000,000 tons a year. Approximately half of this is mined in the Logan District, and about one-quarter in the Konova-Thacker District. The average percentage of fixed carbon in these coals is about 60.[37] The low volatile coals are all produced in the Pocahontas, New River, and Winding Gulf Districts. The combined annual production there is approximately 30,000,000 tons. By far the most important of the three districts is the Pocahontas field, which produces 18,000,000 tons per annum. The remainder of the output is divided equally between the other two areas. This variety of coal has a fixed carbon content of about 70%.[38]

All the steel companies of the Calumet District own mines in either West Virginia or eastern Kentucky, or in both states. In addition, the Illinois and Inland Steel Companies own mines in western Pennsylvania. The development of these coal producing areas has made it possible for the companies in the Calumet District to obtain adequate supplies of coal which produce a coke, equal, if not superior in quality, to the famous Connellsville coke, with which the Pittsburgh steel industry is supplied. The Connellsville coal is eminently suitable for coking purposes, and is a medium volatile variety, having a fixed carbon content of 57%. The Pittsburgh demand for this variety of coal is very great and the reserves are diminishing rapidly. Consequently, Calumet companies have been obliged to look elsewhere for their supplies, and in doing so they have become possessed of enormous reserves. As will be shown in the course of this discussion, they have been able to offset, to a very large degree, the disadvantage

[37]Shurick, A. T., *The Coal Industry*, p. 223.
[38]*Ibid.*, p. 223.

of being obliged to pay the high costs of transporting it some six hundred miles.

Many parts of the Appalachian field have not been touched, partly owing to the lack of demand and partly owing to lack of communications. Mining operations, until quite recent times, had been concentrated largely in the Pennsylvanian portion of this field, and it has been only in the last few years that extensive operations have been carried on in areas more remote from Pittsburgh. Production in eastern Kentucky has doubled in the last twelve years, while there has been also a large increase in that of West Virginia. The mainstay of the coking industry has been the famous Connellsville coal, but the enormous inroads into the reserves in that area are rapidly depleting them as previously noted. The need for large and constant supplies of coal for specialized uses in the metallurgical industries has been responsible for the southward extension of coal production. It has been estimated that the Appalachian coal field contains nine-tenths of the high grade coal of the United States, so that there appear to be adequate reserves for many years to come.

The Eastern Interior field contains large reserves of low grade, high volatile coal. Its inferior quality tends largely to offset the advantage of proximity to the Calumet District. Some of the producing areas are only fifty miles away from Chicago, but their coal is of the poorest grade in the whole field. In Illinois the most important areas, so far as the iron and steel industry is concerned, are the Central District and the Williamson-Franklin District in the southern part of the state. In Indiana, the Clinton and Linton fields are the most important.

Mining Operations.—Mining operations in eastern Kentucky and West Virginia are simple, since the seams outcrop on the hillsides, and drift mining is the general practice (Plate 8). The coal can be loaded almost entirely by gravity into the railroad cars, which are assembled on the valley floor. The development of these mining districts from which the steel industries of Chicago draw the bulk of their supplies of coking coal had to await the building of railroads into the area. When the mining companies commenced operations in these districts communications were exceedingly primitive. The first coal which was produced at Benham, eastern Kentucky, was hauled over the mountains in wagons for shipment by the existing railroad to the Wisconsin plant at South

Chicago. Coal has been the main motive for railroad expansion into these isolated mountain valleys.

Large scale operations appear to be the general rule. This has been found necessary in order to overcome the difficulties of marketing the product from districts which are remote from the consuming centers. Many of the mines are operated and owned by the consumers of the product. The reason for this is, no doubt, the desire to assure themselves of an adequate supply and reserve of special grades of coal. Among the more important of these consumer-owners are the steel companies. As has been noted already, the supply of coking coal is the most expensive item in the manufacture of iron and steel. Hence it is natural that the steel interests should control as far as possible adequate supplies, and so avoid the disadvantages of purchasing from outside sources. "About 50% of the consumer-owned production is from mines controlled by the steel companies, who obtain more than three-quarters of their requirements from their own mines."[39] Some of the more efficient, as well as larger, producing mines in these districts are operated by the steel interests. Perhaps the best example is the mine of the United States Steel Corporation at Lynch, West Virginia, which has the record for tonnage loaded in one day from a single tipple.[40]

In Illinois and Indiana, the coal is recovered both by pit and stripping methods. The better grades are found at an average depth of from 300 to 500 feet. Mining costs are increased by water and gas problems. Many of the mines are operated by large corporations, but there are numerous quite small enterprises in both states. The Illinois Steel Company owns mines in Illinois from which it draws all its supplies of steam coal.

Transportation and Cost of Assembling.—The coal from the eastern mining districts is either sent by rail to Toledo, Sandusky, or Ashtabula, and transferred to lake freighters, which deliver it at the docks of the steel companies in the Calumet District (Plate 9), or it is sent by rail direct. The difference in the cost is approximately fifty cents per ton in favor of the rail-lake route, in spite of the fact that this adds several hundred miles to the distance the coal has to be moved.

[39]Shurick, A. T., *The Coal Industry*, p. 260.
[40]*Ibid.*, p. 260.

Because of the closing of lake navigation in winter, it is necessary to utilize the all-rail route during that time. An adequate supply of coal cannot be accumulated during the navigation season since this type of coal deteriorates rapidly and cokes badly, if it is exposed to the air for several months.

The freight charges by the all-rail route on bituminous coal from eastern Kentucky and West Virginia are from $3.09 to $3.29 per net ton. For Pocahontas coal the charge is $3.29 per net ton.[41]

Four principal railroads handle this movement, the Louisville and Nashville, the Chesapeake and Ohio, the Norfolk and Western, and the Baltimore and Ohio. These lines, with the exception of the last named, make connection with the "Big Four" and Pennsylvania railroads which give access to the Calumet District. Both of the latter, as well as the Baltimore and Ohio, have connections with the three Belt Railroads which serve the various iron and steel mills in the Calumet District (Fig. 2). The location of this district on the eastern approach to Chicago facilitates delivery, which, of course, is made before the congested yards nearer the city are reached.

If the rail-lake route is used, the railroad charges are $2.06 per net ton plus eight cents for loading, which makes a total of $2.14 per net ton on board the freighter. Lake transportation varies from 55 cents to 65 cents, depending on the prevailing rates on ore, and the amount of shipping available. Those companies in the Calumet District which utilize the rail-lake route regularly make annual contracts in the spring for the full amounts to be carried just as is done in the case of iron ore. The freight rates from the mines to the Calumet ports by the rail-lake route average $2.70 per net ton. This represents a considerable saving compared with the charge for the all-rail haul. If allowance is made for the costs of insurance, the share chargeable to coal traffic for the upkeep of unloading machinery at the docks, fire risks, storage costs, and loss of interest on the amount of capital tied up as a result of the large stocks accumulated, the actual amount saved is about 45 cents per net ton. The Illinois Steel Company does not use the lake facilities for the transportation of coal.[42] In 1923, Indiana

[41] I. C. C., 9969.

[42] The Illinois Steel Company operates the plant of the Indiana Steel Company at Gary.

Harbor and South Chicago received 2,402,523 tons of coking coal from the eastern fields by boat from Toledo, Sandusky, and Ashtabula.[43]

The same type of boat and of unloading apparatus is used for coal as for ore. Specialized equipment which dumps the coal into the boats directly from the railroad cars has been devised to make rapid loading possible. Since all the coal is pulverized before being coked, rough handling does not impair its value. Coke, on the other hand, could not be handled in this way because of the breakage.

All the coal from Illinois and Indiana is, of course, transported by rail. Freight rates range from $1.60 to $1.95 per net ton according to the location of the mines.[44] The Illinois Central, the Chicago and Eastern Illinois, and the Chicago Burlington and Quincy Railroads handle most of this traffic. The Illinois Steel Company has an advantage over other producers in that its own railroad, the Elgin Joliet and Eastern, taps some of these mines.

Fuel Consumption.—Economy in the use of coal is a major consideration in the Calumet District. This is necessary in order to minimize the disadvantage of the high cost of transporting coking coal from the mining areas. There are considerable variations in technique, owing to the different conditions under which the iron and steel plants are organized and operated, due in turn to differences in equipment, and viewpoint, but in all of the plants particular attention is paid to the conservation of fuel.

Coal is classified under three heads from the smelters' point of view, according to the purpose it serves, as coke, steam, or gas coal. Coking coal is by far the most important, and all this is brought from the eastern districts. Approximately 8,000,000 tons of this variety are normally consumed each year in the Calumet District.

The high volatile coals from eastern Kentucky and West Virginia are best suited for the making of gas, most of the producer-gas being obtained from this type. No mills in the district utilize Illinois or Indiana coal for this purpose, since a high grade

[43](a) Lake Carriers Association, *Report of Secretary*.

(b) Fig. 2 shows sources and available routes for transportation to Calumet District.

[44]I. C. C., E. 1625 and 8134.

variety is essential to maintain an even heat in the steel furnaces and soaking pits.[45]

It is not possible to determine just how much coal from mines in Illinois and Indiana is consumed by the steel industries in the Calumet District. Probably most of what is used comes from Illinois, since the Inland, Illinois, and Federal companies draw all their supplies of steam coal from that state. The first two companies are by far the largest consumers in the district. The following figures give the consumption of Illinois, Indiana, and eastern coals, excluding anthracite, in the Chicago switching district:

Coal Consumption in the Chicago Switching District, 1917[46]

From Illinois	11,722,911 net tons
From Indiana	5,667,962 net tons
	17,390,873 net tons
Eastern states	8,886,153 net tons
Total	26,277,026 net tons

Of course much of this Illinois-Indiana coal is not utilized in the iron and steel plants, but probably it is true that the steel companies obtain twice as much coal from Illinois as from Indiana.

Illinois and Indiana coal cannot be used profitably as a coking medium. Judge Gary criticised the former in the following words: "The best Illinois coal is cokeable, but in the first place it is very high in sulphur, which could be eliminated at a certain cost, but worse than that, the physical structure is such that it is not practicable. It will not carry the burden of the furnace."[47] Another big defect is the high percentage of ash, which makes its use much more expensive.[48] Similar defects are inherent in the Indiana coal. Consequently, Illinois and Indiana coals are used only for steam purposes. A definite opinion regarding this type of coal was expressed as early as 1864, when Wilkeson wrote, "Bituminous coal, such as has been found best for smelting, contains from 55% to 60% of carbon. Any coal of this kind containing more than 4% of ashes or yielding red ashes is not considered suitable for

[45] Based on information supplied by mill superintendents, and *Iron Age*, January 3, 1924, p. 107.

[46] *Coal Age*, January 5, 1922, p. 18. No figures are available for the years subsequent to 1917.

[47] *Iron Age*, January 7, 1909, p. 2.

[48] Official of Illinois Steel Corporation.

smelting iron, and a small percentage of sulphur unfits it for that purpose."[49] As a medium for raising steam, however, Illinois-Indiana coal is used in large quantities, since it costs less, mainly because the freight rate to the Calumet District is less than that from the East. The present price for Illinois steam coal ranges from $1.65 to $2.00 per ton at the mines. Indiana coal of similar quality varies from $1.40 to $1.75 per ton at the mine. On the other hand, coking coal from eastern Kentucky costs $1.60 to $.175 per ton at the mine. An excellent grade of slack coal, superior for steam purposes to that of Illinois and Indiana, can be bought on the open market at from 75 cents to $1.00 per ton at the mines in eastern Kentucky, but the high freight rate eliminates it from the Chicago market.[50]

As already implied, the most important use of coal in the iron and steel industry is for the production of coke. Coking coal is classified under two heads, low volatile, and high volatile, according to whether it contains more or less than 70% of fixed carbon respectively. The remaining constituents, chiefly compounds of hydrogen and nitrogen, are volatile.

High grade coke is hard, and possesses a fine even texture. Successful smelting is possible only when a good grade of coke is used. The aim, therefore, of every coke producer is to obtain this high grade material. When coal is roasted in a sealed retort, the hydrogen and nitrogen combine and burn. This in turn carbonizes the coal. The more complete this combustion is, the better the grade of coke. If low volatile coal only is used (Pocahontas), the amount of gaseous material is insufficient to cause complete combustion, and the resulting coke is soft and poor in quality. At the same time the by-products resulting from the process are small in amount. If, on the other hand, high volatile coal is used (eastern Kentucky), combustion will be complete, a larger amount of by-products will be produced, but the quantity of coke will be correspondingly smaller. Therefore the problem of the steel companies is to blend these two varieties of coal so as to produce a large percentage of hard coke of good texture, which will stand up well under the load in the furnace and burn evenly, as well as a reasonable supply of by-products.

[49]Wilkeson, J., *The Manufacture of Iron in Buffalo* (1864), p. 5.
[50]The President, Columbus Mining Company, January 22, 1925.

Two factors influence the blending of the two types of coal. In the first place, if a company owns and mines a greater quantity of one particular variety, then more of that kind will be used in the coking mixture, since its own coal will cost the company much less than that which is bought on the market, and it is an advantage to the company to keep its own mines running regularly. Secondly, if the company needs a large quantity of by-products, a larger proportion of high volatile is used. As a result, each company in the Calumet District uses its own particular mixture based on these two factors. The Illinois Steel Company uses 65% of low volatile and 35% of high volatile. This combination yields what is considered to be a very high grade coke, and also a large volume of by-products which are utilized in the plant. This company has large reserves of Pocahontas low volatile coal in West Virginia. The Wisconsin Steel Company uses quite a different mixture. It draws 85% of its coal from its own mines at Benham, Kentucky, and purchases only 15% from West Virginia. Its own coal is of the high volatile type, and therefore it is not surprising to find that it makes its coke from a mixture containing 85% of this kind. The resulting coke satisfies their requirements, and there is a surplus of by-products for sale, over and above what are used in the steel mill. The By-products Coke Corporation only uses 15% of low volatile coal in its coking mixture, since it is particularly interested in producing large quantities of by-products. However, this coke is of sufficiently good grade to command a ready sale to the various independent steel companies, who need extra supplies. The Youngstown Sheet and Tube Company uses 80% of high volatile coal in its mixture, since its major reserves, located in eastern Kentucky, are of this grade, and the resulting coke is satisfactory for its purposes both in hardness and texture.[51]

Since the bulk of the eastern coal is converted into coke at by-product coking plants attached to the steel mills, the relationship between them is very close. Successful co-operation between the coking plants and the steel mills reduces the cost of coke, and this helps materially to offset the high railroad rates on coal. Considerable economies are possible if the by-products from the coke ovens are utilized as fuel. The steel companies, by making their own coke, are able to produce the kind they want, from the

[51]From information supplied by Iron and Steel Mill officials.

particular varieties of coal they prefer to use; at the same time they use a mixture of coals which will give them the amounts of by-products they wish, either to use as fuel or to sell. In some cases there is a surplus which finds a ready market in the neighboring urban districts. In the Calumet District there are 1,038 coke ovens distributed among four of the steel plants. In 1923, these ovens converted approximately 7,000,000 tons of coal into 5,144,000 tons of coke (Table VI). This supply was supplemented by that of two commercial by-product coke companies with an equipment of 385 ovens, which produced 1,557,000 tons of coke from 2,022,000 tons of coal.

Most of the independent steel producers in the Calumet District buy coke produced by the By-product Coke Company. Only the Illinois and Wisconsin Steel companies are self-sufficing.

The largest coking plant in the district is located at Gary, where 700 Kopper ovens carbonize nearly 4,500,000 tons of coal per annum. All of this is transported by rail from West Virginia, eastern Kentucky, and Western Pennsylvania. The Illinois Steel Company considers that the year-round services of the railroad offset the slightly cheaper rates afforded by the rail-lake route, which is only in operation for about seven months each year. Coal deteriorates by standing, even if it is covered, and by utilizing the railroads regularly the company is assured of a daily supply of fresh coal. At the same time, the company's mines are kept running regularly, the necessary storage space is reduced, and the fire hazard is decreased. The railroad companies always offer preferential service for large and regular customers. They themselves are also the biggest customers of the steel company, and consequently it pays the latter to give them employment. The coking plant at Gary is located half a mile from the docks, and if coal were brought by boat it would have to be reloaded into cars and switched to the coal stores. This would increase the handling expenses.[52]

All the other steel companies which have coking plants, utilize the lake vessels to obtain nine months' supply, and by doing so they claim to save from forty to fifty cents per ton in

[52]It seems probable that the Indiana Steel Company did not plan to obtain its coal by lake in order to leave the eastern side of the harbor available for use as an ore dock to serve the National Tube Mills which are now being built.

TABLE VI*

By-Product Coke Capacity of the Calumet District, 1924

	Location	Number	Oven	Annual Capacity net tons	
				Coal	Coke
Indiana Steel Co.	Gary	700	Kopper	4,400,000	3,480,000
Inland Steel Co.	Ind. Harbor	130	Kopper	890,000	666,000
Wisconsin Steel Co.	S. Chicago	88	Wilputte	578,000	376,000
Youngstown Sheet and Tube Co.	S. Chicago	120	Semet-Solvay	864,000	622,000
By-product Coke Co. (Federal Furnace Co.)	S. Chicago	280	Semet-Solvay	1,300,000	975,000
Chicago By-product Coke Co.	Chicago	105	Kopper	722,000	482,000

*Compiled from the *Iron Age*, 1924, and from personal inquiries.

freight rates. They rely upon the railroads to transport three months' supply during the winter. They mix the fresh coal with that already on hand in order to minimize the bad effects of storage.

Very little coke is shipped to the Calumet District. The Gary plants supply all the needs of the Illinois Steel and Indiana Steel companies. The others, with the exception of the Wisconsin Steel Company, purchase extra supplies locally. The latter produces sufficient for two of its furnaces, but when the third one is in blast the coke for it is obtained from Benham, eastern Kentucky, where the company maintains a battery of beehive ovens to take care of this occasional demand.[53]

Where coke ovens function regularly, and are run in conjunction with a steel plant, there is a steady supply of by-product gas and tar, which are available for use as fuel in lieu of coal, producer gas, or fuel oil. Other by-products, such as ammonium sulphate, ammonia liquor, benzol, napthaline, together with any surplus gas and tar, find a ready market in the immediate vicinity.

There is some variation between the different steel plants in the way these by-products are used. The Wisconsin Steel Company runs its Open Hearth furnaces almost entirely on by-product gas. Of the total gas produced at its plant, 35% is used for fuel in the coke ovens themselves, and what is not required in the Open Hearth furnaces is sold to the By-product Coke Corporation which supplies gas to Chicago. On the other hand, the Youngstown Sheet and Tube Company uses tar for heating its Open Hearths, claiming that this fuel maintains a more nearly uniform temperature than does gas, and that this improves the quality of the steel and increases the tonnage produced. Still another variation is adopted by the Inland Steel Company, which uses fuel oil or tar, whichever happens to be the cheaper. The Illinois Steel Company at South Chicago uses other means of economizing in coal consumption, since there is no coking plant attached to those works. As will be shown later, it employs blast furnace gases extensively for this purpose.

Owing to the actual location of some of the fuel consuming departments, to the inadequacy of the supply of by-product gas, or to the small amount required by some particular unit, it is not

[53]The writer is indebted to the officials of the various by-product plants for much of the above information.

always worth while to construct the necessary connections to supply by-product gas. In these cases heat is obtained by using producer gas. This equipment can be installed satisfactorily almost anywhere, and it can be built to supply large or small quantities. The individual units for manufacturing producer gas are small, but larger quantities of gas can be obtained by installing them in groups. Convenience, rather than superior merit, seems to be the reason for the large use of this form of fuel. It is utilized mainly for heating soaking pits and re-heating ovens, in the blooming and sheet mills. In some cases the producer plant forms a part of a particular re-heating furnace. In such cases the additional space occupied is very small. Consequently, this type of furnace is particularly suited to crowded conditions.

Considerable use is made of fuel oil, either alone or in conjunction with tar, in connection with Open Hearth and rolling mill practices. In the various plants using them the choice is determined partly by the prevailing prices of each, and partly by the availability of adequate supplies of tar from the coking department. Where no coking plant is close at hand, as in the case of the Illinois Steel Works at South Chicago, the use of oil is restricted as far as practicable in favor of other types of fuel because of the cost factor. The Inland Steel Company prefers fuel oil for Open Hearth practices because it claims that this fuel reduces the time of "heats" by 10% to 15%, and thereby increases production sufficiently to offset any additonal costs. The installation for fuel oil, or tar, or both, is not difficult to arrange and it is easy to change from one to the other during the process of a particular heat. "Originally the oil was used in the crude form without the removal of any of the more volatile hydrocarbons. Naturally, the low flash point of such oils made them unsafe to handle. Moreover, the development of wider uses for these lighter oils demanded their extraction from the crude. The removal of these lighter hydrocarbons raised the flash point of the residue, giving a resultant product which could be used with more safety."[54]

The fuel oil is imported directly from Tulsa, Oklahoma, since the Calumet District has good railroad connections with that oil-producing center.[55]

[54]*Iron Age*, Nov. 2, 1922, pp. 1138-39.

[55]From information supplied by officials of the steel companies.

In the case of the Inland Steel Company, the oil is unloaded from the cars by gravity, into three 50,000 gallon tanks, and from these it is pumped into three storage tanks of 300,000 gallon capacity, from which it is fed to the furnace.[56]

It seems curious, at first thought, that the local oil refineries do not get a share of this business. The explanation is simply that the Whiting oil interests cannot keep pace with the demand for lighter oils, and therefore have no fuel oil for sale. When they have removed all the products which they need, the residue is useless to the steel companies for heating their Open Hearth furnaces and soaking pits.[57]

The motive behind these variations in the use of particular fuels is clearly to obtain the maximum production with a minimum expenditure of fuel, in order to eliminate in part the disadvantage of the long, expensive, railroad haul for coal.

Conservation Practices Which Economize the Use of Fuel.—Since all the plants in the Calumet District are of modern design and construction, it is possible to adopt all the better practices for fuel conservation. "In every well conducted industry it is the aim to utilize to the best advantage the raw materials entering into the main product. . . . New methods are sought and economies practised which will enable the manufacturer to compete with those more fortunately situated in regard to the available supplies of natural resources."[58]

Utilization of Blast Furnace Gases.—The blast furnace, which is the largest user of fuel, also produces a valuable by-product in the form of gas, in which half or more of the heat value of the coke consumed is present.[59] This gas contains carbon monoxide, carbon dioxide, nitrogen, hydrogen, and water vapor, together with flue dust. The heating value of the gas is derived almost entirely from the carbon monoxide, which represents 28% of the total amount of gas and registers 90 B. T. U. per cubic foot.[60] A modern 600-ton blast furnace uses approximately 560 tons of coke each twenty-four

[56]*Iron Age*, July 10, 1919, pp. 45-46.

[57]Officials of Inland Steel Company.

[58]*Chemical and Metallurgical Engineering*, XXIX, No. 20, November 12, 1923, pp. 873-76.

[59]*Iron Age*, December 20, 1923, p. 1651.

[60]Quarrie, B. D., "Operation of the Blast Furnace," *Iron Ores of Lake Superior* (1923), p. 122.

hours. In the production of 600 tons of iron nearly 70,000,000 cubic feet of gas are produced.[61]

The economies which can be effected by the use of blast-furnace gas for heating purposes, depend upon the type of the equipment employed. The most important device in this connection is the hot blast stove, which requires from 15% to 50% of the total gas produced, according to the area of its heating surface, the type of burner used, and the gas-cleaning equipment.[62]

The dust laden gas is led through dry dust catchers which reduce its velocity, causing much of the dust to be deposited. Dry or wet cleaners are then used, according to the purpose for which the gas is intended. By using clean gas, the cost of cleaning and repairing the stoves is reduced. Its use gives a higher blast temperature, and so reduces the amount of coke necessary to obtain the same tonnage of iron, and thereby the latter is produced less expensively than it otherwise could be. Less gas is also consumed in the stoves, so that more is available for boiler and gas engine uses.[63]

The electric power in all the steel plants is produced almost entirely by the use of fuel, particularly the blast furnace gases, which under the practice of earlier days would have been wasted.

The efficient use of this source of energy is best illustrated by the practice of the Illinois Steel Company, whose plant is almost entirely electrically operated, the power being obtained through the medium of these gases. The company has eleven blast furnaces, and some time ago it was discovered that the production of electric power did not utilize all the surplus gas. The engineer decided to use some of the excess in the reheating furnace of the pipe mill, by mixing it with producer gas, using 40% of the former and 60% of the latter. The results were quite satisfactory. As this did not use all the surplus, six plate mill furnaces were equipped to use the same mixture, with equally good results. Even this did not fully utilize the supply, sufficient remaining to be used in conjunction with tar for the heating of two 200-ton, tilting Open Hearth furnaces of the most modern design. In this case, a 50% mixture of tar and gas was employed, and the only noticeable difference in the performance of these furnaces was that they were a trifle slower in operation.[64] It

[61] *Iron Age*, April 13, 1922, p. 995.
[62] *Ibid.*, December 20, 1923, pp. 1651-52.
[63] *Ibid.*, May 29, 1924.
[64] *Ibid.*, Dec. 20, 1923, p. 1652, and personal inquiry.

may be noted in passing that the Inland Steel Company heats its plate mill furnaces with both producer gas and powdered coal. Consequently, they are more expensive to operate. It should be borne in mind, however, that a very large volume of gas is produced by a plant which has at least six furnaces in operation at one time. Consequently, there is more scope for such economies at plants like that of the Illinois Steel Company at South Chicago, than in smaller ones with only one, two, or three furnaces, since the surplus in these cases is much less. The Gary Plant generates from its blast furnace and coke oven gases all the heat, light, and power for Gary mills, the Buffington Portland Cement plant, and the railroad terminals and shops at Gary, as well as all the light and power used in Gary City.[65]

The Use of Open Hearth Gases.—The gases which escape from the stack of an Open Hearth furnace have an average temperature of between 1100° and 1400° C. If these gases, at such a temperature, are allowed to escape, a very considerable amount of heat energy is lost. A practice has accordingly developed in some plants, including that of the Illinois Steel Company, of passing these gases through waste heat boilers. It has been found that a 75-ton Open Hearth furnace with a properly designed boiler will develop 350 boiler H. P., which means a saving of about twenty tons of coal per day. The larger the plant, the more energy of this type is available, and the more furnaces there are, the more nearly constant is the resultant supply of steam. Pumps, power plants, and other machinery can be run on such "by-product heat" at a very low cost. It can also supply the necessary steam for thawing out ore and limestone piles during severe winter weather.

The Use of By-product Oven Gases.—These gases are distinct from those which are given off by the coal during the process of carbonization. The by-product ovens consist of two sections which operate alternately, each one for thirty minutes, the idle section being heated by the gases of combustion from the active side. Air enters at the bottom of the active section, passes through the heated "checker work," and then joins the gas for combustion in the vertical flues. The gases of combustion next pass through horizontal flues near the top of the oven walls to the opposite half of the battery, whence they pass out to the stack, but on the

[65]From information supplied by an official of the Steel Corporation, and by Gary Chamber of Commerce.

way they heat up the "checker work" of the idle section. The effect of this heating of the air, prior to its entry into the combustion chamber, is to reduce the amount of fuel necessary to maintain a constant temperature. Since by-product gas is the fuel employed, any saving means a larger surplus of this gas for other uses or for sale.

Other Practices For Fuel Economy.—An interesting device, whereby one product which is hot is made to give up its heat to another which requires it, and thereby save the use of direct heat, is to be found in the benzol department at the Wisconsin Steel Company's by-product plant. In this case incoming hot absorbent oil, which carries the benzol products that have been abstracted from the gas, is made to give up its heat to outgoing cool oil by the insertion of pipes bearing the latter inside those carrying the former.

Another device for reducing costs of fuel is to be found at the Inland Steel plant. The electric power to drive one of the rolling mills is obtained from a dynamo which is driven by the steam that has been used to drive the rolls in a blooming mill. Normally this exhaust steam is able to perform this function, but in case additional pressure should be necessary, connections with a steam plant have been provided.

Care is taken that the air blast in the furnaces is perfectly dry, since this reduces the consumption of fuel by twenty per cent, compared with what it would be if ordinary air were used. This practice is particularly significant in the Calumet District, where the humidity normally is high. Careful experiments have shown that the use of dry air also increases the output, owing to the fact that a more nearly constant temperature can be maintained.[66]

These practices, although adopted in most iron and steel districts, have particular significance in the Calumet District, where, as already noted, fuel economy is so vital a matter. Consequently, a careful use is made of all by-products which will serve instead of coal or coke.

Limestone

Approximately 2,500,000 tons of limestone were imported into the Calumet District in 1923, almost all of which was received

[66]From information supplied by officials of the steel mills.

by lake. There are two main sources for this material: (1) the neighborhood of Rogers City on the northern coast of the southern peninsula of Michigan, and (2) Kelleys Island and Marblehead, near the western end of Lake Erie (Fig. 2). Small supplies are obtained from McCook, Illinois, on the outskirts of Chicago.

Suitable fluxing material is supplied by two formations of limestone, Corniferous deposits of Devonian Age in Ohio, and the Dundee Oolite in Michigan. These varieties contain a high percentage of calcium carbonate and have a very low silica and alumina content. Consequently, they meet the requirements for blast furnace operations. The dolomitic Niagara formations which are found nearer Chicago contain 56% of calcium carbonate and 44% of magnesium carbonate; the latter constituent in such abundance makes the stone unsuitable for fluxing purposes. It can, however, be used for furnace linings, or in certain processes of steel manufacture where a highly refractory flux is necessary. The Niagara limestone, which abounds in the vicinity of Chicago, is unsuitable also on account of the clay and other impurities which are imbedded in it. Limestone in its purest form makes the most desirable fluxing material, and the great masses of solid stone which are being quarried in northern Michigan and northwestern Ohio are admirably suitable both in quality and quantity.

Iron ores contain considerable impurities such as silica, alumina, etc., which are not easily fusible. In order to remove these undesirable materials, it is necessary to alter their composition in such a way as to make them less refractory. The calcium of the limestone neutralizes the acids in these materials, and the quantity used is determined by the amount of these acid impurities in the ore. The average amount of limestone used per ton of ore is about 840 pounds. In Open Hearth furnaces it is more essential than in blast furnaces that the calcium content be high, the silica be below 1%, the alumina be under 1.5% and the magnesia be less than 5%. Blast furnaces can utilize satisfactorily flux with a higher magnesia content than 5%, but most smelters prefer the less impure forms.[67]

Dundee limestone underlies almost the whole of the southern peninsula of Michigan, but it only outcrops in a narrow belt along the shore of Lake Huron from Mackinaw City to Alpena, where it is over two hundred feet thick (Plate 10). It is almost pure, having

[67]From information supplied by the officials of the steel mills.

in places a calcium content of 98%.[68] The larger exposures, and those which are being exploited most, occur near Rogers City. There, a high ridge of limestone runs parallel to the shore for about five miles. This bluff overlooks the lake, and is ideally located for bulk shipments by water. Calcite Quarry, operated by the Michigan Limestone and Chemical Company, lies along the lakeside, the base of the quarry being only thirty feet above the lake and the working face from thirty to one hundred feet high. This is probably the largest and most modernly equipped quarry in the world.[69] One of the steel companies of the Calumet District also operates a large quarry in this area, from which it obtains all its fluxing material. Most of the other steel companies likewise get the bulk of their limestone from this area, and since lake freighters can be used, the costs of transportation are low. The average cost of this material, delivered, is about $1.50 per ton. In 1922, the limestone production of Michigan was valued at $4,533,998. Much of this sum was derived from the sale of fluxing material.[70] The reserves are enormous, and at the present rate of consumption the supply available to the steel industry seems more than adequate to meet all future needs. Most of the quarries are owned by large corporations who are interested in the production of limestone for all purposes. The cement industry, however, is particularly important, since the same qualities of stone are essential for this product as for fluxing material.

The conditions at Kelleys Island and Marblehead, Ohio, are equally good for the cheap production of high grade fluxing material in close proximity to one of the Great Lakes and water transportation facilities. The stone lies almost at the surface, and in many places great masses of limestone are exposed. This type of limestone contains 88% of calcium carbonate, and is eminently suitable for metallurgical purposes. The deposits vary from 60 to 110 feet in thickness, and the upper layers are extensively used as a furnace flux. The base of the strata is apt to contain large quantities of fish teeth, which give it a percentage of phosphoric acid and therefore totally exclude it from use as a fluxing material.[71]

[68] *Mineral Resources of Michigan*, Bull. No. 21, Series XVII, p. 159.
[69] *Mineral Resources of Michigan*, Bull. No. 20, Series XVII, pp. 250-51.
[70] *Ibid.*, Bull. No. 34, Series XXVIII, p. 83.
[71] *Limestone Resources of Ohio*, Bull. IV, pp. 159-67.

The fortunate location of such large bodies of almost pure limestone close to the shores of the Lakes, on which it can be transported in bulk to the furnaces, has proved of immense benefit to the Calumet District. No railroad shipment is necessary, and this material can be handled in the same way as iron ore.

As already noted, the local supplies of limestone are not suitable as flux. Moreover, the deposits are less extensive than those in Michigan and Ohio and the rock is more expensive to quarry. There are deposits of suitable material in central Illinois, but the overburden is so thick, that quarries cannot be opened and worked successfully in competition with those in Michigan and Ohio. There are some quarries in central Illinois, as for example, those in Vermilion County, but apparently none of their output is utilized for fluxing purposes in the Calumet District.[72] In Indiana, Bedford limestone occurs in strata thirty to seventy feet in thickness, and much of the waste from the production of building stone formerly was used as blast furnace flux. Railroad freights, however, now prevent it from competing successfully with the water borne product. Furthermore, costs of production are increasing at present, owing to the exhaustion of the more accessible supplies, and the thick bed of clay which overlies much of what remains.[73]

[72] *Mineral Resources of the U. S.*, Part II (1913), p. 1535.
[73] *Ibid.*, p. 1358.

CHAPTER III

LOCAL CONDITIONS IN THE CALUMET DISTRICT FAVORABLE FOR IRON AND STEEL PRODUCTION

The Calumet District, with its abundance of vacant flat land in large blocks, offers excellent and adequate sites for iron and steel mills. Even the marshy conditions have proved to be an advantage, since the waste material can be dumped in the depressions. Plants located along the lake shore have certain advantages over those along the Calumet River in regard to possible extension of area, and waste disposal. As for the water supply, both of these locations have adequate facilities.

Owing to the Nature of the Industry Large Areas of Flat Land Are Required

Owing to the bulky and heavy nature of the commodities that are handled, all the processes of iron and steel manufacture are confined to single story buildings. A modern steel plant is made up of a number of departments, each requiring roomy and specialized buildings. As a result, the area required for a complete installation is large. Each department is an entity in itself, yet there must be a co-ordination of activities in order to produce the finished product. Production must run smoothly in each, since any dislocation in one may seriously affect operations in others. Cramped conditions are highly undesirable. The larger the site, the more opportunity there is for the development of smooth working conditions, and the enlargement of a plant so located presents far fewer problems.

The several stages in the production of steel are sequential and closely inter-related. In order to economize in time and expense, re-heating is avoided as much as possible. This necessitates the rapid conveyance of the molten iron from the blast furnaces to the steel plant. In the same way, the white hot ingots from the latter are conveyed to the blooming mill, where they are either rolled at once, or are stored in the "soaking pits" until they are required. The transference of these materials is carried out usually by the plant railroad system. Since this connects with every department, a large amount of space is occupied by railroad

tracks and sidings. Any restriction of area is bound to affect adversely the arrangement and efficiency of this vital part of the equipment of a steel plant.

In order to avoid delay and confusion, it is essential to have everything moving in one direction, from start to finish. This requisite condition has been met best at the Gary plant of the Indiana Steel Company, where everything moves from east to west. It was possible to arrange for this at Gary, the most modern of all the plants in the Calumet District, because of the large area of the site, and the great care with which the whole enterprise was planned. The site available was 6,000 acres. The original scheme, large though it was, provided in the most minute details for future expansion. As a result all additions have been carried out without disturbance to the older portions of the plant, and have been fitted into the organization without difficulty. This plant is an unusual type, since it was conceived as a large scale enterprise. Most steel mills have been begun in a small way, and when circumstances justified increased production the plant has been enlarged to meet the requirements. This suggests that probable expansion should be prepared for at the outset, and that the area of the site should be gauged according to this scheme. It is, however, very difficult to foresee in any particular case just how far development will proceed. There was a time when the Illinois Steel Company considered that its site at South Chicago was large enough to accommodate all future expansion. Yet before that plant had been in existence 20 years, it was realized that the site was too small, as a result of the rapid expansion at South Chicago, and the limited area available, and the new plant of the Steel Corporation was built at Gary. To enlarge a plant again and again, especially when the area available is restricted, is very difficult. Under such conditions it is usually well-nigh impossible to keep the plant symmetrical, and so the regular flow of the materials is almost certain to be impeded somewhere. No large spaces, suitably located in central Chicago could be found even in 1880, and before that date steel men realized that the wide, empty, spaces of the Calumet District offered unrestricted opportunities. Nevertheless, the founders of most of the present plants failed to foresee the rapid growth that has taken place, so that most of these plants already have nearly reached the limit of their expansion. Hence, in order to prepare for still further expansion, the various com-

panies are continually on the lookout for suitable land, and are making purchases far in advance of early requirements.

Although there is still an abundance of vacant land in the Calumet District, all of it is by no means suitably situated with regard to the iron and steel mills which are located there. The acquisition of more land which is conveniently situated will in most cases not be easy.

There can be no doubt of the superiority in this respect of lake shore locations. Ownership of such a site carries with it the right to fill in the lake to a limit of depth (that of navigable water, twenty-two feet), which is fixed by the Federal Government. This confers an enormous advantage, because a company can add very considerably to its total acreage by such filling. It is less expensive to fill in the water-front than it would be to buy more land. It is doubtful whether, in most if not all cases, land could be purchased which would be situated as conveniently as that which can be built out into the lake, because the latter is located just where it is needed most and where it can be utilized best. Large parts of all the present plants which are located along the shore are built upon "made" land. In Indiana a state tax of one hundred dollars per acre, in addition to the cost of filling, is the only charge in connection with the acquisition of such "made" land. The material used in this reclamation consists of the waste products of the steel industry, mainly slag. Their disposal in this way is both convenient and a source of profit. In this respect, sites along the Calumet River are at a great disadvantage. The companies located there can use their waste to fill in the low, wet, places on their land, thus improving drainage and providing an even surface. When once the required level has been reached, however, they are obliged either to utilize valuable space for dump heaps or to transport the waste material out to deep water in the lake. The acquisition of more land is only possible by purchase, and even then suitably located land is not always available. Even when such land can be bought, the price is very high. In some cases enormous sums are demanded for vacant lots adjoining the property of a steel company. When such exorbitant prices of vacant land are compared with the costs of making land along the lake shore, it at once becomes apparent that, in a rapidly expanding industry such as the manufacture of iron and steel, the shore locations are distinctly preferable to river front sites. A specific

example will illustrate this point. The Wisconsin Steel Company urgently needs more land. Adjoining its mill there are unoccupied lands which are ideally located so far as the needs of this company are concerned, but which cannot be bought at any reasonable price. Meanwhile, the company is expanding to the limit of its capacity. Yet a large section of its property between 99th and 106th Streets is utilized as a dump for slag and other waste products.

Certain disadvantages are associated with lakeside locations. A number of railroad lines hug the lake shore as they traverse the Calumet District. These restrict expansion landward, make access to the mills less convenient, and even cut certain properties into two parts (Fig. 1).

In the case of the Inland Steel plant at Indiana Harbor, the furnaces are separated from the older established steel mills by the tracks of the following railroads: Elgin Joliet and Eastern, Baltimore and Ohio, Pennsylvania, and New York Central. In order to transfer hot metal from the blast furnaces to the Open Hearth plant on the south side of the tracks, it has been necessary to construct tunnels, through which the ladles are carried on the company's own railroad system. This has added considerably to the costs of production.

A similar tunnel was constructed at what is now the plant of the Youngstown Sheet and Tube Company. This serves a double purpose. The company's by-product coke plant is situated on the south side of the same group of railroads, and the gas and tar are conveyed to the furnaces by pipes which pass through this tunnel. Pedestrians also use the tunnel when entering or leaving the plant, and thus avoid the danger of crossing a number of busy railroads. All vehicular traffic, however, must cross the tracks in order to enter or leave the works. All the coal which is brought to this mill by boat is unloaded at the ore docks into railroad cars, for conveyance to the store piles beside the coke plant. It would be much cheaper and more expeditious to utilize a bridge conveyor, but the railroad companies will not permit one to be built over their tracks. This is a very definite disadvantage to the steel company.

At South Chicago, the Elgin Joliet and Eastern Railroad tracks run alongside the property of the Iroquois works and separate them from a tract of vacant land, which has a good water front and which adjoins Ewing Avenue, one of the main

business streets. This piece of land is useless to the Iroquois Company on account of its small size, and because access to it would necessitate the construction of a tunnel under the railroad. To do this would involve the sacrifice of too much land which is occupied by buildings, and a capital outlay much greater than the small addition would justify. Were it not for the railroad this land could be readily combined with the already crowded site. Landward expansion is impracticable, and the Company has extended its site lakeward to the limit of its riparian rights, so the further enlargement of this plant is almost impossible.

At Gary, the Indiana Steel Company was sufficiently influential and wealthy to be able to move three sets of railroad tracks back from the lake shore to suit its own convenience. At the same time it elevated them so that there could be unrestricted movement in and out of the mills. Thus the disadvantages which are experienced at the Indiana Harbor plants were obviated. This company owns ample land along the shore to provide for its probable expansion for many years to come.

One particular problem associated with the size of sites in the Calumet District, particularly in the case of those of restricted area, is the necessity for adequate space to store winter supplies of ore, fuel, and limestone. These storage piles form an imposing feature at all the plants (Plate 11). The enormous quantities of these bulky commodities which must be accumulated by the end of each navigation season would impress even a casual observer. It would be difficult, if not impossible, to secure sufficiently large sites within the congested areas of a large city to admit of so much land being utilized in this way. Should it be necessary to obtain additional supplies of ore during the period of closed navigation, railroads, with their much higher freight charges, would provide the only available means of transportation. Since cheap ore is essential to the success of the iron and steel industry in the Calumet District, the importance of having ample storage space is evident.

The disposal of slag, which is produced in such enormous quantities, represents one of the outstanding problems of those companies which are located along the Calumet River. It is not so serious at present to those whose plants occupy lake shore sites since, as already noted, they can use slag to build land out into the lake up to their riparian limits. The usual plan adopted to this end is to enclose a portion of the lake area which is destined

to be filled. Molten slag is then run directly from the slag notch of the furnace into this enclosure. This is convenient and permits inexpensive filling. Furthermore, it is necessary because no molten slag may be dumped into the open lake, since on coming in contact with the water the slag disintegrates and contaminates it over a wide area. Only cold slag therefore can be used to fill nonenclosed 'areas. When the lake shore companies have built out their shore lands to the limit permitted, they will be in much the same predicament as those along the river, except that they are located more conveniently to load the material on barges and dump it out in the lake at a distance from shore.

As already noted, the Wisconsin Steel Company, whose site along the Calumet River is limited to 142 acres, is obliged to utilize a large area of its property as a slag dump. The remainder of the site is almost entirely occupied by the plant, and each addition to the latter is made with increasing difficulty, owing to lack of adequate space. Slag disposal is a very real problem, and smelting operations have to be adjusted to meet this difficulty, particularly with reference to the use of limestone.

The composition of the slag is vital to the production of iron. "Its degree of fusibility governs the length of time that it will be exposed to carbon for the absorption of the same, and the percentage of bases will determine the affinity for sulphur and silica. In smelting rich ores the slag must be kept more refractory than when working lean ores, as the degree of basicity determines the fusibility and also its ability to carry off sulphur. Slag containing a high percentage of lime and low magnesia will cause the slag to slake if on the basic side."[1] Therefore, since slag is so important in the production of iron, little can be done to alter its composition without affecting the grade produced. The best flux is almost pure calcium carbonate, but the resulting slag, when cold, is soft and very limy. Such a slag is useless to construction companies, who require large amounts of ballast, concrete, and roofing material. They will take only a hard slag which will wear like stone, mix as well in concrete, build solid roads, and so on. In order to produce a slag which can be sold, the Wisconsin Company uses a mixture of 20% dolomite and 80% calcite limestone in its furnaces.

[1]Quarrie, B. D., "Operation of a Blast Furnace," *Iron Ores of Lake Superior* (1923), pp. 121-22.

This makes a satisfactory fluxing material, gives a clean separation in the hearth of the furnace, and produces a hard slag which actually wears better than stone, as ballast material. Such a mixture does not "gum up" the furnace as one would do which contained a larger percentage of dolomite.

The Illinois and Indiana Steel companies have an additional outlet for their immense slag production. The Buffington Portland Cement Company was founded in order that this waste product could be utilized in a more profitable manner. Two qualifications are essential in order that the slag may be used in the manufacture of portland cement. It must not contain more than 4% of magnesia, and it must be cooled instantly and completely, in sufficient water to cause it to granulate. The latter gives the cement its hardening properties. The advantage of an abundance of cool water is obvious.[2]

Portland cement is normally a calcined and ground mixture of limestone, chalk or marl, and clay or shale. At Buffington, finely ground slag replaces, in part, the limestone. Abundant supplies are easily obtained, either from the South Chicago or Gary mills, since the Elgin Joliet and Eastern Belt Railroad connects the three plants. The United States Steel Corporation is preparing to spend three million dollars in the immediate future on improvements and additions to the Buffington plant. It has planned to construct a harbor and dock for the handling and storage of limestone, slag, and coal, and for the shipment of cement by lake. An additional cement plant of the latest type also will be constructed.[3]

There are a number of other ways in which slag could be utilized to advantage, provided the iron and steel companies would go to the expense of providing the necessary equipment. That they have not done so yet is evidence that the problem of slag disposal has not yet reached the critical stage.

"Eisen Portland Cement" is being made extensively in Europe. This is a mixture of 35% ground slag and 65% Portland cement. This product is almost as strong as Portland cement itself, and is considered to be even more resistant to the action of sea water and alkali. There would seem to be a demand for such a cement in the

[2]Quarrie, B. D., *loc. cit.*

[3]*Chicago Tribune*, February 12, 1925.

United States sufficient to justify such a product, and the resources of the Calumet District make it a suitable center for its manufacture.[4]

Slag, mixed with lime, will also make good bricks for building purposes. Bolckon, Vaughan and Company formerly made these "limeslag" bricks, at Cleveland. They consisted of 88% ground granulated slag and 12% hydrated lime. This mixture was made into a stiff paste, put in moulds, and then passed through 200-ton presses. After being steam dried, a perfectly formed, uniform, strong, brick was obtained. Careless manufacture brought them into disfavor, and their production ceased. If made properly, they form a very serviceable brick, and their extensive production would call for large supplies of slag.[5] Experiments have shown that a better brick of this type can be produced. They are made in the same way, except that 12% of cement replaces the hydrated lime. These bricks do not require to be steam dried. They dry satisfactorily in the open air and are ready for use almost immediately, although storage for some three months improves their quality. They are very hard and strong and make excellent building material.[6]

Basic slag makes an excellent fertilizer. As such, its value is well known in Europe, where it is employed extensively for this purpose. When applied in conjunction with steamed bones, it forms a useful source of phosphoric acid. The basic lining of a Bessemer converter yields a phosphorus-free metal and a highly phosphatic slag. If the latter is ground fine an excellent fertilizer is produced. Open Hearth slag yields a lower percentage of phosphorus, and in the Calumet District, where the ores used have a low phosphorus content, such slag has little fertilizing value. The usual yields in England and Germany are higher, as a result of a difference in the phosphorus content of ore which is used. In the Calumet District, only the basic slag from Bessemer converters could be utilized profitably for agriculture. On the other hand, the use of basic slag in American agriculture is very restricted, and most of that so employed is imported. Rock phosphates abound in the United States, and fertilizer can be obtained

[4] *Iron Age*, April 17, 1924, p. 1152.
[5] *Iron and Coal Trades Review*, November 9, 1923, pp. 1689-90.
[6] *Ibid.*, p. 1691.

more readily from these. However, this use for basic slag offers a means of disposing of at least some of the large tonnage produced.

The gases leaving the blast furnace carry with them comparatively large quantities of fine material consisting of ore, coke, and limestone. If a furnace is working irregularly, the particles are apt to be much coarser than otherwise would be the case. Normally, the iron content of this flue dust is approximately the same as the grade of ore being used. Consequently it is worth while to collect this material from the washers, but considerable space is required for its storage. The average production of flue dust is about two hundred pounds per ton of iron produced, and until a few years ago this was wasted. Now most plants in the Calumet District have some method for reclaiming this waste material and for returning it to the furnaces. To put it back in the form of dust would be useless, since it would be blown out again almost immediately. The dust carries 8% to 10% of carbon, and this is the medium by which it is made to coagulate. One method is to ignite the carbon content in a Sintering plant, and the resulting heat causes the mass to fuse into pieces as large as, or larger than, marbles. These can be fed back into the furnace successfully. Another method is to make briquettes by passing moulds containing the dust through a furnace heated to 2500°F. This temperature fuses the briquettes, while the carbon is consumed. The resulting product is a good substitute for hard ore, as a medium for facilitating the regular working of a furnace using fine grained Mesaba ores.[7] Where one of these methods is not employed, all this material is wasted. Moreover, it has to be dumped with the slag, and its disposal becomes a more or less serious problem, as the site of a particular plant becomes more and more congested.

An Adequate Supply of Water Is Available For All the Iron and Steel Plants

The steel industry could not function without an enormous supply of clean, soft water. This is utilized for steam, for cooling, and for gas washing purposes, and the requirements amount to many millions of gallons per day. Any plant located on the lake

[7] Crowell and Murray, *Iron Ores of Lake Superior* (1923), pp. 122-23.

shore or along the Calumet River can be sure of an adequate supply. It is a comparatively easy and inexpensive operation to draw the necessary volume of water from either of these sources. It would be far more expensive to obtain the same quantities from wells, and the supply probably would be much less certain. Hence the matter of water supply will restrict the expansion of the industry in the Calumet District to areas which are contiguous to either the lake or the Calumet River.

Detailed figures of the total consumption of water by all the companies are not available, but sufficient data can be given to indicate the importance of location with reference to an ample water supply. The large volume is due to the necessity of having running water in all parts of the plant. The Inland Steel Company is one of the larger consumers. In Plant No. 2, located south of the railroad tracks, 15,000,000 gallons are required daily. The new plant (No. 1), will require very much more when intended developments have been completed. The present pumping equipment of No. 1 plant is as follows—3 pumps with a capacity of 3,500 gallons per minute, 2 of 4,200 gallons per minute, and 5 of 8,000 gallons per minute. These 10 pumps are driven electrically, and can draw approximately 85,000,000 gallons from the lake every twenty-four hours. This makes a total pumping capacity of 100,000,000 gallons daily for the two plants. In 1919 the daily consumption averaged 67,000,000 gallons per day, which were distributed through the plants in a series of water mains having a diameter of thirty-six inches.[8] Since then, the consumption has been largely increased as a result of additions to the plant, and when the new 600-ton blast furnace comes into operation further increases will take place.

The Illinois and Indiana Steel companies, with their large plants at South Chicago and Gary, use much more than the Inland Steel Company. One official estimated it at something above the amount used daily in the city of Chicago for municipal purposes (800,000,000 gallons). Since the Illinois and Indiana Steel companies together have seven times as many blast furnaces as the Inland Steel Company, and since their other equipment is correspondingly more extensive, the foregoing estimate seems not unreasonable.

[8](a) *Iron Age*, July 10, 1919.
(b) Verified by the officials of the company in a personal interview.

The Youngstown Sheet and Tube Company draws 150,000,000 gallons daily from the lake, while the Federal Furnace Company uses 18,000,000 gallons. Steel plants require much more water than those which are exclusively blast furnace plants, owing to the more diversified activities carried on in them.

The advantage of location near Lake Michigan can be recognized clearly when conditions in the Calumet District are compared with those of inland locations. At Youngstown the steel plants are strung out along the river from which they draw their supplies of water. At Canton, Ohio, where no river or lake supply is available, the United Alloy Company has been obliged to bore eleven artesian wells to obtain its requirements. Such a means of supply is much more costly, both to install and to maintain, than the simple equipment involved in drawing water from the lake, and the supply is much more uncertain. The water which is obtained from these wells is so hard that the company is obliged to soften it artificially before it can be used. On the other hand, the water from Lake Michigan can be used in its natural condition.

The presence of Lake Michigan certainly has solved the water problem, and these illustrations are sufficient to show that an abundant supply is very essential to the iron and steel industry. In this respect the Calumet District has very distinct advantages, owing to its lakeside location.

CHAPTER IV

LABOR CONDITIONS

Labor supply, urban expansion, and industrial development are related so closely one to another, that, as a rule, the growth of any one of them stimulates that of the others. In its broadest sense industry is dependent upon labor, and vice versa, so that a progressive industrial area is extensively urbanized. Most industries have had their beginnings in places where a surplus population could be drawn upon to supply the necessary labor. The only alternative has been to import the requisite labor by creating sufficiently attractive conditions.

Labor Supply

Throughout its industrial history the Calumet District has been on the margin of a populous and rapidly growing city, with the result that it has been possible to bring labor to the iron and steel industry easily. When the first steel plant was located at the mouth of the Calumet River, the particular site for it was chosen because it was beyond the residential sections of Chicago. Industrial sites farther up the river were chosen for similar reasons. Their original labor supply was drawn from the city, but in course of time much of the contiguous area has become more or less urbanized. Chicago has spread rapidly and in the process has absorbed South Chicago. With this city growth, a wide variety of other industries have come into existence in the Calumet District, which have further attracted labor and stimulated the building of houses near the industrial sites, since it is more satisfactory if workers are housed conveniently near to their work.

The more distant mills at Indiana Harbor and Gary can now be reached readily from the city, owing to good railroad facilities, but prior to 1910 these facilities were little developed. Large scale urbanization schemes, therefore, were required in order to attract labor to the areas where it was most needed. The growing urbanization of recent years has been the means of attracting, of retaining, and of building up a stable industrial population.

Many nationalities can be found in and around the iron and steel mills. In one plant there are sixteen, and notices are posted in several different languages. The executive work and the more

skilled artisan labor are carried on, for the most part, by Americans, but the bulk of the semi-skilled, and unskilled labor, is done by foreigners. Men of similar nationalities, such, for example, as Poles, Czechs, Italians, Austrians, Mexicans, and Germans, are drawn into the same sorts of jobs. Thus, as a result, most of the men employed in the rolling mills tend to be Poles, the furnace men are largely Austrians, the railroad men, Italians, and so on. This has a disadvantage from the administrative point of view, in that the individual members of these groups tend to support one another and make it difficult to trace the cause of minor troubles. Consequently, efforts are made to mix the nationalities so far as it is practicable. Most smelters prefer to employ Americans, but it is only in the last few years, since the adoption of the eight-hour day, and the general improvement of working conditions, that these have been attracted to the industry in any considerable number. Mexicans and negroes are least desired of all on account of their irregular habits and lack of stamina, although there are many individual exceptions to this general rule. Most of the foreigners will submit to longer hours, since they are concerned mainly with earning as much money as possible, regardless of health and comfort.

Industrial Expansion Has Necessitated Urban Development

With the improvement of means of local transportation, the area has increased from which a particular industry may conveniently draw its workers, so that the modern tendency is to extend the residential districts farther and farther away from the industrial plants.

West of Lake Calumet, residential districts have developed that resemble those along the Calumet River, especially since the establishment of fabricating plants has encouraged labor to settle in their immediate neighborhood. The gaps between communities have been gradually reduced, owing to the increase in the population consequent upon the growth of the iron and steel industries, and the rise of other industries. The expansion of Chicago southward has tended to fill the gaps north and west of the Calumet District. The relation between the industrial and residential sections can be recognized clearly. Westward expansion of residential districts has been encouraged by the greater attractiveness of those sections farthest removed from the factories. Rail-

roads and street cars, as well as automobiles, have made it convenient for people to live relatively far away from the mills.

The eastern section of the Calumet District has developed rather differently from the western section. The industries were planted where the population was very sparse, where means of communication and the amenities of life had to be developed rapidly in order to attract and keep labor. Since urban communications were not good in most of these sections, the residential development took place around the individual plants. As the industries grew, and new ones came into existence, the necessary improvements in transportation facilities were provided, with the result that there has been a steady expansion of residential districts at considerable distances from the center of the community to which they belong. Hammond has developed around the steel car shops located there, and modern facilities have increased its capacity for becoming a residential area for workers in a number of the neighboring steel mills. Indiana Harbor and East Chicago grew up with the steel plants and their associated industries. Whiting owes its existence and development to the oil interests.

A similar condition may be noted in its earliest stages at Ford City. Henry Ford recently erected a large plant at some distance from South Chicago, in the center of a large vacant area. The workers are drawn from considerable distances. A part of the area adjoining the plant has been subdivided, and the building of a city to house the employees of this factory has been commenced. Any new industries which may locate in the neighborhood obviously will stimulate this city growth.

The steel corporations have done much to provide houses and to encourage urban development around their plants, in order to stabilize labor. The outstanding example of how an industrial enterprise can influence the settlement and urbanization of an area is to be seen in the case of Gary. In less than twenty years, a city of imposing proportions has arisen, in what was formerly a desolate waste of dunes and marshes, with no natural attractions whatever for residential purposes. The steel industry was responsible for the change. The Gary steel mills began operations on a very large scale, and, therefore, the initial labor force was numerous. To maintain this force, the Steel Corporation took a lively interest in the planning and the laying out of a model industrial city in a place where few would have dreamed a city

would be built. The need was pressing. Almost before the plant had fairly started to make steel, its labor force numbered about 15,000.[1] Hence the very rapid growth of Gary. The Steel Corporation provided large funds to assist the early developments. As a result, the plan of the city was co-ordinated with that of the steel mills to which it owed its existence. The success of the project was undoubtedly due to the enormous resources back of it, but once well launched, development was natural.

The following citation from the *Iron Age* illustrates what had been accomplished by 1909. "The city of Gary was therefore laid out just south of the steel works, upon an orderly plan and comprehensive scale, taking into account its probable growth to metropolitan proportions. Already Gary has an estimated population of 15,000 before the plant has fairly started, and is provided with an adequate waterworks system, whose permanent water supply will be drawn from Lake Michigan through a tunneled intake now under construction; an electric lighting plant, an electric street railway and a complete sewerage system. . . . The main street has its northern terminus at the entrance to the steel plant. . . . Two lines of railroad, the Baltimore and Ohio, and the Central Indiana and Southern, ran through the center of what is now the mill site. Over forty miles of new railroad were built, and both the above roads were re-established by the corporation on rights of way passing between the town and the mills. The tracks at this point are elevated to allow an unobstructed entrance to the works. . . . The entire plan embodies an adjustment of structural arrangement to the convenience of local transportation, rather than to alignment with compass lines, and constitutes not only a departure from precedent but is productive of an unusual degree of flexibility in the interchange of traffic."[2]

During the first six years of its existence, housing facilities were far short of requirements, and many employees were forced to live in surrounding towns. In 1911, nearly one thousand homes were built, and fifteen hundred were planned in 1912. After the early years, the real estate dealers began big development schemes. Addition after addition was made to the city, and

[1] *Iron Age*, January 7, 1909.
[2] *Iron Age*, January 7, 1909.

the population increased by leaps and bounds. Broadway, the main commercial street, extends north and south for five miles, and the built up area has extended south for the same distance, although with decreasing density as the distance from the center of the city increases. In 1910, the population was 16,802; in 1920, 55,378; in 1924, 73,837. These figures indicate the enormous growth in eighteen years, for in 1906 the area was practically unpopulated. The Indiana Steel Company generates the bulk of power, 6600 volts, which is used in the city for commercial and industrial purposes. It supplies washed blast furnace gas to operate thirty-four 3,000 H. P. engines, which in turn generate 2500 K. W., also for use in the city. It is no exaggeration to say that the whole life of the community is bound up with the steel mills.[3] Gary, then, strikingly represents one phase of effort which was expended to make iron and steel manufacturing possible in this section of the Calumet District.

Mark City is another example of the active part taken by a steel company in developing housing facilities for its employees, but compared with that in the case of Gary the effort was very small.

A distinctive feature, so far as the residential districts east of Lake Calumet are concerned, is the preponderance of houses, rather than of large apartment buildings. This indicates the less crowded conditions existing there, as compared with those in South Chicago or in Chicago itself. In classifying the residences into four grades, it was found that those sections which house the foreigners of relatively recent arrival were of the poorest grade. On the outskirts of such centers as Hammond, Gary and Blue Island, far removed from the industrial plants, the best houses are located. The poorest types, in all cases, were found to be situated close to the factories. This is especially noticeable in Hammond. There is a definite separation of different nationalities, since colored and foreign sections can be clearly distinguished. There is one exception to this, however; it is not possible to distinguish between types who occupy the intermediate grades of houses. The distinction is only possible among the poorer elements; Americanization and prosperity tend to break up the grouping by nationali-

[3] *A Survey of Gary*, Industrial Committee, Gary Chamber of Commerce, p. 3.

ties. The colored people, however, are definitely segregated. Throughout the western parts of the district the prevalence of apartment buildings gives them a distinct similarity to most parts of Chicago.

At the present time, the trend of urban expansion is being guided by large development companies, who are thinking in terms of cities rather than of individual blocks or lots. They have turned their attention to those areas which are located along the southern margin of the Calumet District, where conditions are especially favorable for residential development. There seems to be a general policy of leaving the present unoccupied areas to the north of the Grand Calumet River for future industrial use, and to encourage residential development farther and farther away from the lake. The general unpleasantness of living under crowded conditions around the big industries is recognized. In Gary, many employees in the steel mills have established their homes five miles south of the lake. At Hammond, all the finer residential sections are located on the extreme southern fringe of the town, the reason being that much more pleasant surroundings are to be found on the slightly elevated, well drained lands of the moraine country, with their fertile loamy soils, than on the low, poorly drained lands of the lake plain, with their hopelessly sandy soil. This southern development has been possible because of the development of street car and motor bus services which provide rapid and cheap transportation to most of the industrial plants. Each community has more or less adequate street car services which, in most cases, are linked with those of the neighboring systems. Most of the western sections can be reached by this means from Chicago. The large number of private automobiles has increased the distance at which people can live and yet be conveniently located to their work.

The bulk of this residential expansion southward is taking place betwen Gary and West Hammond. Farther west, there seems to be none. The agricultural land between Hammond and Blue Island appears to be typically rural, without any obvious urbanization schemes afoot. Urban expansion is taking place in the areas north and west of Kensington and Pullman.

It should be noted that building operations of considerable magnitude are in progress within the various cities of the eastern section of the district. These represent the gradual completion of

projects which were initiated in the past. They represent a response to the continued demand for houses on the part of those people who cannot leave the vicinity of their work, or whose interests demand their residence in or near the center of the community.

The existing urban development is clearly a result of the industrial demands, for its growth has been stimulated, and in some cases directed, by the needs and progress of the large scale industries within the district. Urban conditions, on the other hand, have done much to stabilize labor, and to create favorable conditions for the growth of a local supply.

The Suburban Railroad Facilities

The development of suburban railroad services has kept pace with the expansion of settlement. The Illinois Central and Rock Island railroads tap the main residential and industrial points in the western and southwestern parts of the district, and provide interurban, as well as Chicago connections which are adequate for the needs of the community.

In the same way, the trunk lines which cross the eastern sector of the Calumet District provide for a large daily movement in and out of the industrial sections.[4] Trains are scheduled at the times which suit the steel mill workers, so that many of these are able to live at comparatively long distances from their work. Indeed, many who live well within the Chicago city limits work as far out as Indiana Harbor.

These suburban services make the whole district readily accessible from Chicago. Additional rapid transportation is provided by the Chicago Lake Shore and South Bend Electric Railroad.

[4]The following railroads cross the district in the immediate neighborhood of the steel mills: New York Central, Wabash, Pennsylvania, Baltimore and Ohio.

PART II

MARKETING ASPECTS

CHAPTER V

THE CALUMET DISTRICT IN RELATION TO ITS MARKETS

The Calumet District occupies a strategic position between two great complementary regions, the industrialized East and the agricultural West, which should make it an ideal center for the production and the distribution of a wide range of iron and steel goods. Its relatively central location, with regard to the North American plain, which is one of the most productive agricultural areas in the world, and an enormous market for iron and steel, gives it an advantage over other industrialized areas lying farther east. The twenty-seven converging trunk railroads, together with the Great Lakes waterway, offer abundant facilities for the distribution of manufactured goods over a very wide area. The Calumet District has advantages for production which should enable it to develop an even larger industry, since, under existing conditions, iron and steel can be made more cheaply there than anywhere else in the United States.

The Natural Markets of the Calumet District

The Market in Chicago. The Calumet District has all the advantages of proximity to Chicago, the greatest commercial and industrial center in the interior (Fig. 3). Consequently, there is a very large market near at hand for the products of the local steel mills. Chicago and its vicinity have many large scale industries, and a large population. Moreover, the whole area is developing very rapidly. Consequently, its needs are expanding at the same rate. Table VII indicates the major activities carried on within the city limits. It does not include those industries which are located at Whiting, Hammond, East Chicago, Indiana Harbor, and Gary because no separate statistics are available for these cities. Consequently, it indicates only part of the manufacturing carried on in metropolitan Chicago. Almost all the industries create some demand for iron and steel, directly or indirectly, and the natural source of these materials is the local mills.

The Character of the Market in Chicago and the Nature of Its Demands.—The fabrication of iron and steel goods is one of the

TABLE VII*

MANUFACTURES OF CHICAGO

	Value of Products	Value Added by Manufacture	Wage Earners
	Millions of dollars		Thousands
Agricultural Manufactures			
Slaughtering and meat packing	1083	125	45
Leather tanning, etc	51	16	4
Food products	57	9	3
Malt liquors	21	15	2
Soap products	26	6	2
Flour and grist mill products	22	3	0.4
Lumber Manufactures			
Mill products†	..	..	..
Furniture	92	47	22
Pianos†	..	..	..
Iron and Steel Manufactures			
Foundry and machine shop products	139	84	29
Railroad cars	119	52	27
Agricultural implements†	..	..	..
Electrical machinery	78	41	16
Automobiles (including parts)	69	20	6
Clothing			
Men's	190	103	37
Women's	64	25	9
Miscellaneous			
Printing and publishing	157	95	21
Bread and bakery products	78	32	10
Confectionery	53	24	2

*Compiled from the U. S. Census of Manufactures, 1919.
†No statistics available.

major activities throughout metropolitan Chicago. This creates a large demand for iron and steel in all its forms, which can be supplied by local mills.

A large number of industries relating to railroading have been established in and around the city, on account of its position at the center of the densest railroad net in the country, and the availability of raw material. Apart from the terminal shops for the repair and maintenance of locomotives and rolling stock, which are to be found in connection with all the railroads which enter Chicago, there are a large number of factories engaged in the production of new material. Locomotives, cars of all kinds, and

... are made near the iron and steel mills, while the small

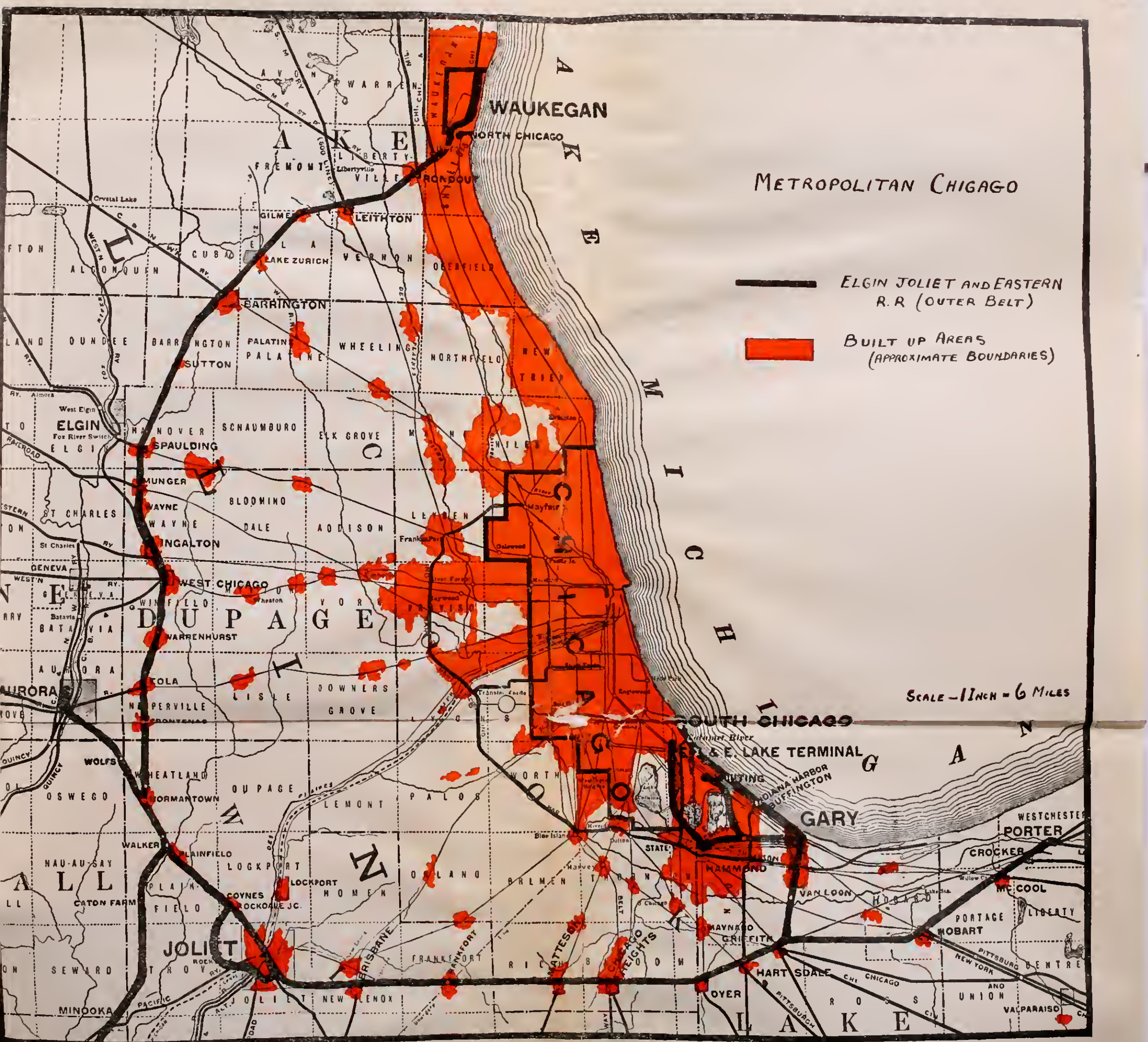

METROPOLITAN CHICAGO
ELGIN JOLIET AND EASTERN R.R (OUTER BELT)
BUILT UP AREAS (APPROXIMATE BOUNDARIES)
SCALE - 1 INCH - 6 MILES
WAUKEGAN
NORTH CHICAGO
ROND0UT
LEITHTON
LAKE ZURICH
BARRINGTON
SUTTON
ELGIN
SPAULDING
MUNGER
WAYNE
INGALTON
WEST CHICAGO
WARRENHURST
AURORA
EOLA
WOLFS
NORMANTOWN
PLAINFIELD
LOCKPORT
JOLIET
BRISBANE
FRANKFORT
MATTESON
CHICAGO HEIGHTS
SOUTH CHICAGO
E. J. & E. LAKE TERMINAL
INDIANA HARBOR
BUFFINGTON
GARY
HAMMOND
MAYNARD
GRIFFITH
HARTSDALE
DYER
PORTER
CROCKER
MC COOL
HOBART
VALPARAISO
LAKE MICHIGAN
CHICAGO
DUPAGE

FIGURE 3

equipment of all sorts, are produced in large quantities for distribution throughout the country, but particularly in the West, Northwest, and Southwest. The large demand for rails, plates, bolts, spikes, etc., for distribution along the various routes also can be supplied conveniently from the Calumet District.

Railroads always have played an important part in the development of the iron and steel industry in the Chicago District. The demand for iron rails in the middle of the nineteenth century led to the establishment of the early rolling mills, and of the car and locomotive shops. The first plant in the Calumet District was built to supply steel rails. Railroads have never ceased to be the largest consumers of steel. In 1924, they utilized 28% of all the steel produced in the country (Table IX).

The natural place for the factories manufacturing this type of material is near the source of iron and steel, provided this source is advantageously located with reference to the dominant market and transportation facilities. Hence there are a large number of such factories in the Calumet District near all the steel mills, or in close connection with them through the medium of the belt railroads. Some of these factories have a very large production. The Standard Steel Car Company consumes 300,000 tons of plates annually, as well as many tons of bolts and shapes. The Pullman Company manufactures the bulk of its cars within Chicago, and most of the steel which it requires is available at the Calumet mills. The Griffin Wheel Company of West Pullman produces 1000 wheels per day, and is one of the more important industries of its kind in the country.

It was estimated that the construction of railroad equipment and locomotives consumed 7,452,000 tons of steel in 1924 for the United States as a whole (Table VIII). It is impossible to say, in the absence of definite statistics, just what proportion of this was manufactured in the Chicago District, but the presence of so large a number of railroad and car shops would indicate that the amount was very considerable. The figures in Table VII only represented part of the consumption, as has been noted, since all the Calumet District is not included.

Foundries and machine shops of all kinds consume a very large amount of iron and steel owing to the extensive manufacture of these products throughout metropolitan Chicago. The more bulky forms are made near the iron and steel mills, while the small

TABLE VIII*

ESTIMATED CONSUMPTION OF STEEL IN 1924. APPROXIMATE AMOUNT OF EACH FORM TAKEN BY EACH OF A NUMBER OF INDUSTRIES.

(Thousands of Tons)

	Rails	Splice bars, tie-plates, etc.	Plates	Shapes	Bars	Sheets (not including black plate for tinning)	Tin Plate	Wire Rods	Pipes and Tubes	Hoops, Bands, Cotton Ties, Strip Steel, etc.	Forging Blooms and Billets	All Other	Totals
Automotive (including trucks, tractors, etc.)	.....	24	205	24	1,035	615	.....	105	27	345	16	125	2,511
Railroads (including cars and locomotives)	1,860	600	1,380	968	780	525	1	68	42	58	210	960	7,452
Agriculture	3	.....	38	13	150	95	.....	385	1	24	95	33	837
Buildings (bridges and other construction, not railroad)	8	2	575	1,940	740	250	.....	290	910	55	.....	70	4,840
Shipbuilding	5	.....	115	55	38	6	.....	3	2	2	.....	12	238
Containers (principally food)	.....	.....	4	.....	3	130	895	26	5	66	.....	.....	1,129
Machinery (electric, textile, machine tools, etc.)	.....	1	92	69	550	29	.....	63	2	17	2	99	924
Oil, gas, water, and mining	89	15	417	118	108	95	56	40	1,400	27	4	28	2,397
Exports	204	24	138	133	100	375	180	207	228	27	.....	54	1,670
Miscellaneous	551	36	275	210	960	855	235	1,115	500	231	26	540	5,044
Totals	2,220	702	3,239	3,530	4,464	2,975	1,365	2,302	3,117	852	353	1,921	27,042

**Iron Age*, Jan. 1, 1925.

specialties are made in all the industrial sections. The total value of steel used for these purposes amounted to $5,000,000 in 1919.

Chicago is famous the world over for its agricultural implements and machinery. The International Harvester Company utilizes most of the product of its subsidiary, the Wisconsin Steel Company, which amounts to 250,000 tons of steel per annum.

Chicago has adopted the lofty type of steel building, and the construction of these results in a large demand for structural steel, most of which is fabricated in the immediate vicinity of the mills. A feature of the weekly journals interested in iron and steel, is the enumeration of building permits and their steel requirements. These structures may be department stores, hotels, office buildings, new manufacturing plants, banks, warehouses, etc., called into existence by the rapidly growing commercial and industrial activities of the city. "Building construction in Chicago made an excellent showing in 1921. . . . Permits were taken out for 7800 structures, extending over a frontage of 233,025 feet and involving a total cost of $124,028,010, as compared with 3745 buildings on 135,550 feet of frontage and a cost of $79,102,650, in 1920."[1]

The extensive oil refineries at Whiting, with their storage tanks and specialized rolling stock, constitute another important local market for steel products. The American Tank Car Company, at East Chicago, is one of the more important producers of tank cars in the United States.

The extensive electrical and automotive industries offer another important local market. These industries consumed raw materials to the value of $80,000,000 in 1919, much of which was iron and steel. These industries particularly affect departments producing sheets, cold rolled steel, bars, and wire products.

A glance at the list of manufacturing activities in Chicago shows the extensive markets for machinery and many varieties of specialties, all of which utilize iron and steel directly or indirectly.

It is impossible to discover just what proportion of the total Chicago consumption is supplied locally. Nor is it possible to even estimate the total consumption, since no statistics are available for a number of important industries, owing to the danger of disclosing individual operations.

[1] *Iron Age*, January 12, 1923, p. 167.

The Markets Beyond Chicago.—The location of the Calumet District, in the heart of the continent, with adequate communications radiating in all directions, favors a wide distribution of products. The evidence laid before the Federal Trade Commission made it clear that the production is greater than the demands of Chicago and its immediate vicinity, and, therefore, there is a surplus for wider distribution. This market should include all those sections of the United States which naturally look to this center as a source of supply. These should include all states to which iron and steel can be supplied more cheaply than from other producing centers. Under normal trading conditions there should be no difficulty in serving this extended market, since almost every form of iron and steel needed is produced in the Calumet District. In limiting the market, costs of transportation exert an important influence.[2]

The Pacific coast region, as a rule, does not form a part of the Calumet market, because the eastern Pennsylvanian mills are located strategically nearer the Atlantic seaboard, and under normal conditions, ocean transportation, by way of the Panama Canal is cheaper than the all-rail haul from the Calumet District. Between 1914 and 1920, however, slides in the Panama Canal, and the almost complete withdrawal of coastwise shipping during the war period, disrupted the usual channels of this trade. Ocean rates were increased greatly, and it became necessary to utilize the railroad facilities.

The Calumet District, being located farther west than the other big producing areas, was able to obtain a large share of the Pacific Coast trade, since it was cheaper to ship iron and steel from that district than from Pennsylvania. The Illinois Steel

[2]Freight rates on finished steel products from Pittsburgh and Chicago consuming points per 100 pounds, are as follows:

To	*From Pittsburgh*	*From Chicago*	*To*	*From Pittsburgh*	*From Chicago*
Atlanta	$0.58	$0.67	Kansas City	$0.735	$0.35
Beaumont, Texas	0.705	0.49	Memphis	0.56	0.42
Birmingham	0.58	0.53	New Orleans	0.67	0.57
Casper, Wyoming	1.15	0.835	Omaha	0.735	0.35
Chattanooga	0.50	0.49	Pacific Coast	1.15	1.00
Chicago	0.34		St. Louis	0.43	0.35
Cincinnati	0.29	0.28	St. Paul	0.60	0.275
Columbus, Ohio	0.255	0.29	Shreveport, Louisiana	0.79	0.63
Dallas, Texas	0.885	0.69	Smackover, Arkansas	0.62	0.60
Denver	1.15	0.82	Toledo, Ohio	0.27	0.265
Detroit	0.29	0.275	Tulsa, Oklahoma	0.885	0.645
Houston, Texas	0.89	0.49	Wichita	0.89	0.585
Indianapolis	0.31	0.25			

Hammond Chamber of Commerce, February, 1925

Company alone shipped 178,000 tons in 1918 to consumers in that distant market. Before the end of 1920 coastal shipping became normal, and ocean freight rates dropped, so that the Calumet mills lost the Pacific Coast trade to eastern producers. In 1922, the Illinois Steel Company shipped only 1,400 tons there, and since then it has ceased to serve that area.[3]

Some areas in the South and Southwest can be supplied more cheaply from the Birmingham district, or by means of coastwise shipping from eastern Pennsylvania. Extensive territory can be served more conveniently from a number of less important iron and steel centers, such as Duluth and St. Louis. Production at Provo, Utah, probably will determine, more and more, the western boundary of the Calumet market.

The lower costs of production in the Calumet District have tended to give the producers there a tremendous advantage over other areas, and should help to offset the costs of reaching the more distant markets.

Had it not been for the arbitrary control of price levels at Chicago and at Pittsburgh, the eastern limits of the Calumet markets would be marked by a north-south line drawn approximately midway between Chicago and Pittsburgh. Such a line would pass through Detroit and Toledo, and would run well to the east of Columbus and Cincinnati. If prices were lower at Chicago, then this boundary line would be pushed farther eastward, until the additional costs of transportation counterbalanced the difference in prices.

Throughout the territory west of this line, the Calumet producers would have had to fear no competition, provided their selling prices had been no higher than those in Pittsburgh, because the cost of transportation would have proved an effective barrier to eastern products. Only in the case of shortage, or where certain types of products not made in the Calumet mills were required, would there have been any movement into the western markets from eastern centers. The best example of the latter type of case is the distribution of special shapes which are made by the Bethlehem Steel Corporation. These are marketed all over the country. In 1922, 17 per cent of the total production of these shapes was sold west of Chicago.[4] For similar reasons, many of the blue annealed sheets from Gary have been sold in the East.

[3]*Iron Age*, July 12, 1923, p. 83.
[4]*Iron Age*, May 24, 1923, p. 1481.

The Character of the Market.—The Calumet District serves a market which demands the entire range of iron and steel products. The dominant economic activities of this market are associated with agriculture, mining, cattle raising, and many phases of manufacture and transportation. All of these activities exert a powerful influence on the production of iron and steel.

The demand for agricultural machinery and equipment comes mainly from the Middle West, Northwest, and South. Much of this machinery is supplied by fabricating companies in the vicinity of Chicago, which are conveniently located with reference to the steel mills. Many small fabricating shops, however, are scattered throughout the region. These should draw their supplies from the Calumet mills, which are the most conveniently located and can supply all their needs. In addition, large quantities of wire products are required for fencing and other purposes in the farming and grazing areas where lumber is scarce, and therefore, expensive. It was estimated that in 1923 farmers and ranchers utilized from 60 per cent to 75 per cent of the total output of these products, and the Middle West and Great Plains region constituted the more important markets. Galvanized sheets also form another large item of western consumption, as a substitute for lumber and other building material.[5]

The growth of population and urban centers, with the resulting industrial and economic development throughout the great area tributary to Chicago, has increased the demand for structural steel. This is fast replacing lumber in modern specialized buildings and factories, partly owing to the decreased fire hazard which its use entails, and partly to the increased price of lumber resulting from the exhaustion of the more accessible supplies. Reinforced concrete is being used in rapidly increasing amounts, and this requires large quantities of iron and steel bars of many sorts and sizes. The Calumet mills are situated conveniently to supply much of this need, particularly in the West, and the production of these commodities is one of their chief interests.

The enormous growth of the automotive industry has been responsible for a large increase in the production of plates, bars, and sheets. Steel of particular grades plays an important part in the construction of automobiles, tractors, and trucks, and in making numerous parts for them in specialized plants. The great

[5] *Iron Age*, January 3, 1924.

extent of the country, the general prosperity, which has prevailed in recent years, of the farming and industrial communities, the increasing use of automotive equipment in agriculture, in industry, and in other lines, together with the widespread need for rapid transportation to supplement that afforded by the railroads, all have contributed powerfully to the rapid development of this industry. The chief manufacturing centers of these products are located advantageously with reference to the Calumet District, which supplies much of their raw material.

The gas, water, heating, and sanitation systems, of most of the urban centers, are dependent upon adequate supplies of pipes. In addition, the exploitation of mineral resources is dependent upon this type of product. The Calumet producers are favorably located to supply much of the iron and steel, mainly pipes and sheets, needed in the development of the mid-continental oil fields. This group of consumers has been responsible for the growth of a highly specialized branch of steel manufacture in the Calumet District.

The expansion of manufacturing in the Northern Interior, particularly in the north central states westward of Ohio, has stimulated the production of many kinds of machinery. This has provided an important outlet for the products of the Calumet mills over a very extensive area.

The provision of arterial highways constitutes another use for steel products. Wire mesh is used extensively for reinforcing the concrete surface of roads. The building of bridges requires a large tonnage of structural steel, which can be supplied to many areas more conveniently from the Calumet mills than from those located in the East.

The extensive canning industry of the Northern Interior provides another important use for steel. The large quantities of fruit, milk, vegetables, corn, and meat, which are canned each year, create a large demand for tin plate, which is produced extensively at Gary.

The foreign market has played a larger part in the distribution of the products of the Calumet District than might have been expected from its inland location. The importance of this was due to artificial arrangements which functioned as a result of the "Pittsburgh Plus" system, arrangements which offset the disadvantages of a location remote from the seaboard.[6]

[6]Federal Trade Commission, *Docket 740*.

Tables VIII and IX show the consumption of steel for the United States as a whole. No figures are available to show what

TABLE IX*

Distribution of Steel Among the Chief Consuming Groups in the United States

Group	1924 %	1923 %	1922 %	1921 %
Railroads (incl. cars and locos.)	28.0	27.0	22.0	17.1
Building and Construction (not R. R.)	18.0	15.5	15.0	14.2
Automotive	9.0	11.0	10.0	9.8
Oil, Gas, Mining, Water	9.0	10.5	10.0	7.7
Exports	6.0	6.0	7.0	13.4
Agriculture	3.0	3.0	4.0	3.6
Food Containers	4.0	4.0	4.0	3.1
Machinery	3.5	3.5	2.8	4.5
Shipbuilding	.8	.8	.9	2.6
Miscellaneous	18.7	19.5	28.0	23.7

*_Iron Age_, January 1922, 1923, 1924, 1925.

amounts of each type of product originated in the Calumet District. The figures show clearly the relative importance of each major use and the type of product.

Transportation Facilities of the Calumet District in Relation to Marketing

As already noted, the Calumet District has excellent transportation facilities for distributing its products very widely. Most of the iron and steel moves out by rail because the chief consuming areas lie to the west, south, and east. Little has been done to utilize the Great Lakes waterway as a medium for distribution.

Railroads.—Owing to the nature of the commodities handled, and the location of the markets, railroad facilities are most vital to the iron and steel industry. Proximity to Chicago gives the Calumet District the advantage of utilizing all the trunk lines which have terminals there. These lines radiate in almost all directions, and give rapid and direct communication with every section of the United States (Fig. 3).

All those from the East are forced to pass round the southern extremity of Lake Michigan in order to reach Chicago. The Calumet District lies athwart their paths. A number of these lines follow the lake shore, and their presence was one of the reasons for the location of the steel mills. These lines offer the most direct communication with the East.

The belt railroads provide connections with all the twenty-seven railroads which radiate from Chicago, and also handle purely local distribution.[7] These serve the individual plants, whether the latter are located on the trunk lines or not, and they penetrate into all parts of the district. They form three concentric, but irregular rings around and through metropolitan Chicago, and intersect all the trunk lines which leave the city. At these points, they offer direct connection with all of these trunk lines, which maintain clearing yards nearby. Any steel plant located on any railroad in the district can ship its products with a minimum amount of delay and switching. This is almost equivalent to being located on all the railroads which enter and leave Chicago. Shipments to or from the Calumet District can be received or dispatched through the medium of the belt railroads and clearing yards without entering Chicago, with the result that they avoid the congested traffic of the city, and thus reach their destinations in less time. Gary has the advantage of from twenty-four to thirty-six hours over Chicago for all shipments to and from the East.[8] It should be borne in mind that the belt lines represent a great number of combinations and amalgamations of many smaller lines which were not planned originally as part of a comprehensive whole. As the industrialization of the Calumet District progressed, these small lines were built to serve specific interests, and to link them with particular trunk lines. These small lines have been merged gradually into three main systems which function entirely as freight carriers, having no interest whatever in passenger services.[9]

[7](a) Elgin Joliet and Eastern R. R. (Outer Belt).
(b) Indiana Harbor Belt R. R.
(c) Baltimore & Ohio Chicago Terminal R. R.

[8]Gary Chamber of Commerce.

[9]From information supplied by an official of the Indiana Harbor Belt Railroad.

The Elgin Joliet and Eastern Railroad (the Outer Belt) is controlled by the United States Steel Corporation, which owns the majority of the stock. The main purpose of this system is to link up all the mills in the Calumet District which are owned by this corporation, with similarly owned plants at Joliet and Milwaukee. Rapid intercommunication between these plants is thus effected. Although this railroad acts as a common carrier and comes within the jurisdiction of the Interstate Commerce Commission in regard to freight charges, it is not difficult to understand that the corporation traffic has preference. The profits which result from its operations form a part of the income of the United States Steel Corporation. The various subsidiary companies of the latter which use it are charged the same rates as the general public. This railroad does not encourage Chicago switching traffic. It is concerned primarily with corporation and through movements.[10]

The Outer Belt line begins at the Illinois Steel Company's plant at South Chicago, and follows the shore to Whiting, Indiana Harbor, Buffington, and Gary, tapping, on the way, all the steel mills and the more industrialized sections of the Calumet District. Branch lines serve the Calumet River sections, as well as the oil refineries at Whiting, and make connection with the Outer Belt line just south of Gary, by way of Hammond and Shearson. Classification takes place at Kirk Yard. From Gary this belt line runs in a great arc well outside the Calumet and Chicago districts, avoiding the congested areas near the city. Rapid through transportation is facilitated because the points at which it crosses the main trunk lines converging on Chicago are farther apart than those nearer the city. This enables the trains to attain a greater speed in the intervening sections. The greater speed in turn offsets the greater distance covered. The United States Steel Corporation mills in Joliet obtain their ore and limestone from South Chicago over this route. The corporation is able, therefore, to transport these materials on its own railroad, and thereby keep the business entirely in its own hands, with considerable saving in costs. In the same way, crude iron and steel can be carried to the northern plant of the corporation at Milwaukee with much greater dispatch than by any other route. Figure 3 indicates clearly the territory covered by this line, and its position relative to the

[10]From information supplied by officials of the company.

Indiana Harbor Belt Railroad is indicated in order to emphasize the wide sweep which it makes in order to avoid Chicago.

The Indiana Harbor Belt Railroad is less easy to trace, either on a map, or on the ground, since it is located nearer to the city than the Outer Belt, and therefore functions under more congested conditions. Like its rival, the Outer Belt, it makes a circuit around Chicago, but east of Blue Island it penetrates the industrialized sections of the Calumet District. Another complicating factor in connection with this railroad is that the company has running rights over the tracks of other companies, with the result that it is difficult to follow all of its ramifications. From Blue Island the line runs to West Hammond, where it sends a branch down the east side of the Calumet River to join the main tracks of the New York Central Railroad. It also has running rights down the western side of the river over the Calumet Western tracks, which also have connection with the New York Central. It is thus able to serve all the iron and steel plants along the river. East of Hammond it serves the industrialized sections both north and south of the Grand Calumet River as far east as Gibson, where its main clearing yard is situated. Its tracks penetrate every part of East Chicago and Indiana Harbor where it serves the steel mills. From the latter point the company has running powers over the New York Central tracks to South Chicago, which enable it to tap the oil refining sections by a loop which swings around the Jones-Laughlin site and back to Roby. It also serves the Iroquois blast furnaces at South Chicago. It has running rights as far east as Dune Park, well beyond Gary, which will enable it to serve any future industrial development in that part. The ramifications of this belt line within Chicago are still more complicated, but they do not form a part of this study. It performs the same type of work as does the Outer Belt, except that it has a much wider range of customers, and serves the whole of metropolitan Chicago. Cars from the Calumet District are collected at the Gibson Yards, and from there are dispatched to the various trunk lines running north, east, south, and west (Fig. 1).

The growth of this particular railroad can be seen from the following data. In October, 1912, it had 2084 employees with a monthly payroll of $145,736. In 1917, there were 2999 employees who earned $286,151 per month. In October, 1922, the number of employees had increased to 3,664 with a monthly payroll of

$566,839. This represents a 75 per cent increase of personnel in ten years, and a payroll approximately doubled.[11] Since 1917, the number of loads has increased by 30 per cent. The bulk (90 per cent) of the business of this railroad is in the Calumet District. From 1912 to 1922, the number of cars to and from the various industrial plants increased from 68,075 to 159,312.[12]

The Baltimore and Ohio Chicago Terminal Railroad (B. & O. C. T.) forms the innermost of the three belt lines which serve the Calumet District. This line performs all the functions of a switching agent, but it does so at some disadvantage compared with either of the others. Its chief disadvantage is due to its location nearest to the congested districts of the city. The points of intersection with the main trunk lines are much less widely separated than in the case of either the Outer Belt or the Indiana Harbor Belt, with the result that traffic along it is slowed down at much more frequent intervals. The through movement of goods by this road is therefore slower, particularly within the city limits. This road also enters the Calumet District at Blue Island and from that point parallels the Indiana Harbor Belt line as far as Hammond and East Chicago, from which places it sends branches to the oil refineries at Whiting, and to the southern sections of East Chicago. The latter enable it to handle iron and steel products from the various fabricating plants of this section of the Calumet District. From East Chicago it runs east to Clark Junction, where it turns west and forms one of the group of railroads which parallel the lake shore to Indiana Harbor, where it can compete with the other belt roads for the business of the steel mills. At this point it makes connection with the Baltimore and Ohio trunk lines, which enables it to tap the South Chicago industrial district. The bulk of its business in the Calumet District is carried on with the oil companies and the fabricators of iron and steel. It adds an additional transportation facility for the major interests of the district, but its proportion of the total traffic is much less than that of either of its two rivals.

Most of the steel mills utilize the services of either the Outer Belt or the Indiana Harbor Belt. The Illinois Steel Company and the Indiana Steel Company, being subsidiaries of the United

[11] *Pep in Calumet*, Hammond Chamber of Commerce, March, 1924, p. 18.
[12] *Ibid.*, p. 18.

States Steel Corporation, use the former only. The Inland Steel Company, being the chief rival of the Illinois Steel Company, uses only the latter. The other steel producers use both in varying proportions. The competition between the three lines tends to maintain the standard of efficiency on all.

For the distribution of commodities within the Calumet District each belt railroad company performs the necessary switching operations, if the plant to which a particular car is consigned is located on its own road. If it is on another road, then the car is taken to the nearest clearing yard on that line, which delivers it to its destination. The fact that the shipper can stipulate the route by which his goods are to reach their destination, enables him to use the one which serves him best, and the belt lines offer him prompt connection with any one he may choose.

Switching rates are from $5 to $14 per car, according to the nature of the services rendered, throughout the "Chicago Switching District."

Trucking.—Trucking plays only a minor role in the district, so far as the iron and steel mills are concerned. Their products require, for the most part, railroad facilities. Many of the fabricating plants, producing lighter forms of finished goods, do utilize trucks for purely local traffic, but the belt railroads, with their elaborate system of inter-communication, can carry out local distribution much more effectively since they cater for less than carload lots as well as for the more bulky loads. This applies equally to goods destined for Chicago or for points more remote.

Lake Transportation of Iron and Steel.—As briefly indicated, very little iron and steel is shipped out by lake. In the main the markets lie in the opposite direction, and railroads are better suited to carry the amounts which are marketed at points along the lake shores. The ore boats are not designed to carry cargo of this type, although occasionally some small consignments are taken by them to the Upper Lake ports for which they are bound. The main function of these boats is to move ore as rapidly as possible, and since they could not hope to get a full cargo of iron and steel in any direction, and since small cargoes are not profitable, very little of these commodities is handled by them.

The United States Steel Corporation recently has begun to ship some of its products by lake. It has built two electrically propelled vessels, of 2100 tons burden, to handle the movement

of some of its own mill products from ports on Lakes Erie and Michigan. Those two vessels, the "Steelvendor" and the "Steelmotor," represent a distinct departure from the ordinary bulk freighter, which is steam driven, and which is of too great size to pass through the Welland Canal. The new type of vessel is designed to operate on the Great Lakes and the St. Lawrence in summer and fall, and along the Atlantic and Gulf coasts in winter. They have two loading lines, one for lake operations and the other for ocean work, the latter when they operate in Atlantic and southern waters, carrying the products of the Steel Corporation from New Orleans and Mobile to various other ports. In this way the boats can be in operation all the year round. All their equipment is electrically operated, and they are provided with loading and unloading machinery which makes dock equipment unnecessary. They are designed to carry structural steel, rails, billets, plates, tin plate, and structural sections up to sixty-five feet in length.[13] The success of these boats already has been demonstrated, and other companies may follow the example of the Steel Corporation.

Artificial Restrictions to the Markets of the Calumet District

Until the abolition of "Pittsburgh Plus" in 1924, normal competitive conditions did not exist among steel producers in different parts of the country. The advantages of its central location near Chicago, and of cheaper production were not permitted to function for the advantage of the Calumet District either in Chicago or in the Northern Interior. An artificial check was put both upon production and distribution. "The development of the steel producing mills at Pittsburgh is abnormally increased because, under the Pittsburgh plus system, the market of the Pittsburgh mills is the entire United States. The development of the steel producing mills outside of Pittsburgh is restrained because they are obliged to share their markets with the Pittsburgh mills and cannot, without lowering their prices, invade other markets."[14]

Prices in Chicago, with a few exceptions, were determined in the following way. If steel was selling at Pittsburgh for $30 per ton, then the Chicago price was $30, plus the prevailing freight

[13] *Iron Age*, Jan. 24, 1924, pp. 289-90.
[14] Federal Trade Commission, *Docket 740*, p. 18.

charge from Pittsburgh to Chicago, which in 1924 was $7.60 per ton. The Chicago fabricator always paid this additional amount whether the steel he purchased was made in Pittsburgh or in the Calumet District. This gave the Calumet producer a higher profit for his steel in Chicago, which offset lower profits obtained at points east of that center, and permitted him to distribute his orders among eastern and Calumet plants to suit his own convenience. As a result production in the Calumet and the Pittsburgh Districts rose and fell simultaneously.

When the "Pittsburgh Plus" system was instituted in 1900, Pittsburgh was the center of cheapest production. Under those conditions the evils of a base price were not so great. But circumstances have changed. The Calumet District produces at lowest costs today, but the system remained until 1924 as it was. Consequently, production in all areas west of Pittsburgh has been made subservient to that center.[15]

Owing to the discriminatory prices charged by the steel companies under this system, it was possible for the Pittsburgh producers to compete in Chicago on terms of equality with those of the Calumet District. Under normal conditions the only products which could enter this market were those which were not produced locally. These comprised those "shapes" which were only made at eastern mills. Apart from those, local production was more than ample for the demands of Chicago and its vicinity. Since costs of production were approximately 15 per cent less than in Pittsburgh, and an additional $7.60 per ton for railroad freights was entailed before the latter could put its product on the Chicago market, there seems to have been no justification for the influx of steel which took place from that center. Since the major producers in the Calumet District are subsidiaries of eastern corporations, some of the needs of Chicago were supplied from eastern mills, rather than from local sources. This certainly was true not only when the Calumet mills were busy and eastern plants slack, but also when trade was slack everywhere.

The Pittsburgh producer likewise shared the western and northwestern markets on equal terms with those of the Calumet District, in spite of the fact that the latter was considerably nearer to these areas and had a large surplus available for distribution outside Chicago. Thus, the purchaser in Duluth paid the Pittsburgh price, plus the railroad freight from that center,

[15] Federal Trade Commission, *Docket 740*.

whether the steel was made at Chicago, Milwaukee, Pittsburgh, or Duluth itself.

Under the "Pittsburgh Plus" system everyone knew exactly what he would get for steel sold in the territory of the competitor, since everyone sold on the same basis. If any firm broke away from this national scheme the Calumet producers adopted f. o. b. mill prices in order to protect themselves. This checked competition effectively. In 1921, an eastern competitor of the Chicago mills in the sale of plates, bars, and shapes, started price competition. The Calumet mills at once quoted f. o. b. Chicago prices, which were maintained. But since this competitor only cut prices on these particular commodities, the Pittsburgh prices were retained on all others.[16] " 'The Pittsburgh Plus' system causes a greater tonnage of steel products to be shipped by eastern mills into the West than by western mills into the East, because of the fact that the market of the Pittsburgh mills is the entire country, including the West, while the western mills cannot go into the East without taking lower and lower prices the farther east they go."[17] In order to cope with this difficulty the Calumet producer was obliged either to curtail his production or to "dump" his surplus into eastern areas or abroad, where the profits were very much less than in Chicago or the Northern Interior. The Illinois Steel Company was stated to have sold as much as 50 per cent of its production in areas east of Chicago. Almost all of the other producers were obliged to do the same thing in a greater or lesser degree. Yet their natural market lay west rather than east.[18]

If free competition had existed the Calumet producers would have lowered their prices, as they easily could have afforded to do, and would thereby have retained these markets for their own products. Instead of doing so, they maintained price levels at $7.60 above those at Pittsburgh. Consequently, the advantages of location were used to increase profits and not to compete with eastern producers. Independent producers in the district probably benefited more than those who were subsidiaries of eastern companies. "Chicago could sell most of the products, if it indulged in a price competition with Pittsburgh, as far east as Pittsburgh and still make the same profit that Pittsburgh would make. In some cases, it could upon a strictly price competitive basis, drive

[16]Federal Trade Commission, *Docket 740*, p. 26.
[17]*Ibid.*, p. 25.
[18]*Ibid.*, p. 25.

Pittsburgh out of all markets of the country. . . . Under free competition Chicago would in the long run become the quantity production center for the country in competition with Pittsburgh."[19]

The Probable Extent of Markets with the Abolition of "Pittsburgh Plus"

Because of the recent elimination of "Pittsburgh Plus" the market of Calumet producers certainly will include presently all of Illinois and the contiguous states. Competition in the West, Northwest, and Southwest will be easy to meet, since the Calumet producer is nearer to these markets than any eastern producer. If prices are maintained on a par with those at Pittsburgh, as seems most likely, the eastern boundary to this tributary area will extend midway between Pittsburgh and Chicago, in keeping with the natural competitive relations already indicated. If Calumet prices are lower, then the producers there should have no difficulty in extending their markets over a still wider area, provided production is adequate to serve this extended market. At present this is impossible, but within a few years the capacity of the Calumet mills can be so enlarged that there should be no difficulty in ousting eastern producers from what may be termed the natural hinterland of the Calumet District. What influence the great corporations, who have plants scattered over the country, will have in checking the full development of the possibilities of the Calumet District remains to be seen. The enormous expense entailed in building a modern steel plant doubtless will be a factor in the situation. The obvious disadvantages of tearing down established plants and replacing them in more suitable areas, or those attending the total abandonment of mills in one place and the building of new ones elsewhere, are recognized. Such drastic methods are too expensive to be adopted on a large scale. What is more likely to happen is that new plants and extensions will be built in the Calumet District rather than in Pittsburgh, in order to tap the western markets. It seems probable that in the long run the Calumet District will become the chief center for the production of iron and steel in this country.

[19] *Iron Age*, May 8, 1924, p. 1346.

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Plate 1.—Mining Operations at Hibbing, Minnesota, on the Mesaba Range.
Courtesy of the Penton Publishing Company, Cleveland.

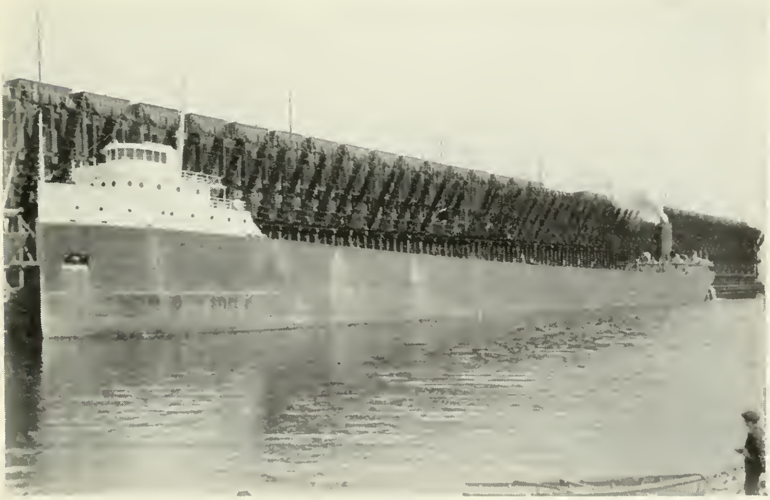

Plate 2.—A modern Lake Freighter alongside the Ore Dock at Escanaba. The hatches of the boat are spaced the same distance apart as are the spouts to facilitate loading operations. *Courtesy of the Escanaba Chamber of Commerce.*

Plate 3.—A section of the Ore Docks at Duluth showing loading operations in progress, the dock structure, and the loading spouts.

Courtesy of the Illinois Steel Company.

Plate 4.—The mouth of the Calumet River showing the ore docks of the Iroquois plant on the right and part of the Illinois Steel Plant on the left. The Elgin, Joliet and Eastern railroad crosses the river by the bridge in the foreground.

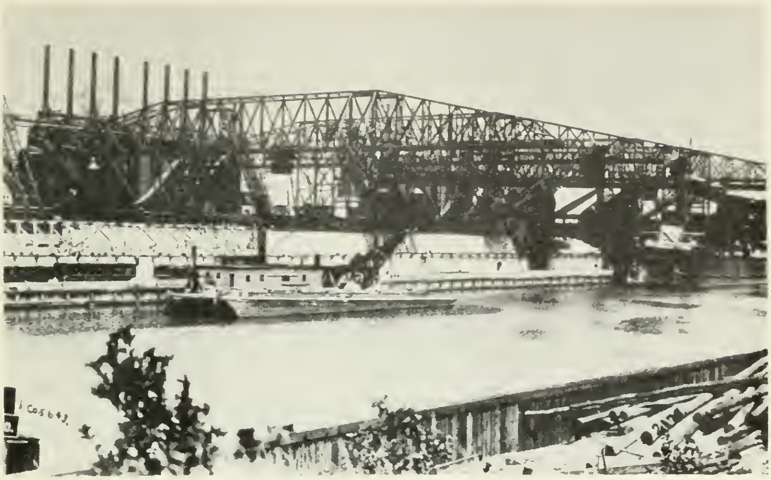

Plate 5.—The artificial "slip" harbor at Gary, the ore docks, a vessel being unloaded, and part of the blast furnace plant operated by the Indiana Steel Company. *Courtesy of the Wellman-Seaver-Morgan Co., Cleveland.*

Plate 6.—A 5-ton Clam Shell in the hold of a Lake Freighter. The picture indicates the construction of the boats to facilitate rapid, unimpeded unloading. *Courtesy of the Illinois Steel Company.*

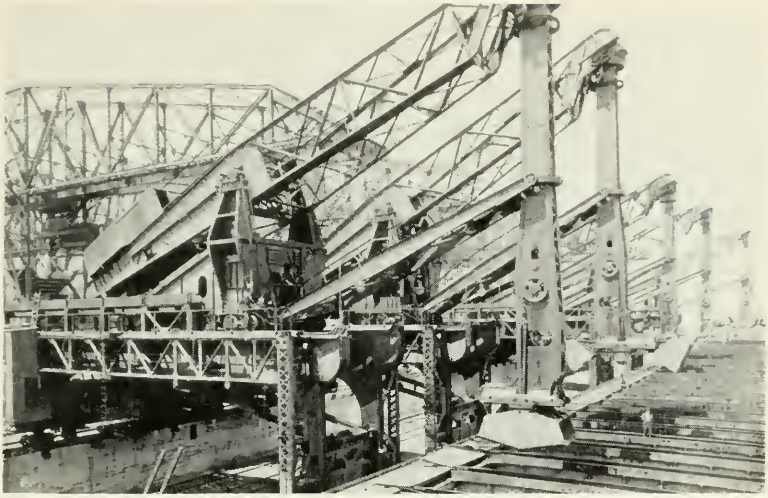

Plate 7.—A close view of the latest type of electrically operated unloading machinery at Gary. The deck construction of the boat facilitates the operation of all the equipment at the same time.

Courtesy of the Wellman-Seaver-Morgan Co., Cleveland.

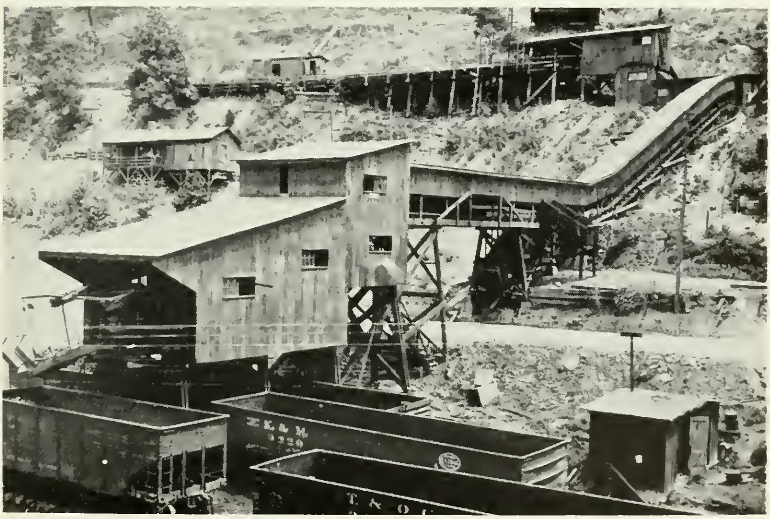

Plate 8.—Coal mining operations at Christopher, eastern Kentucky. The conveyor, tipple, and the hillside location of the drift are typical of the operations in the Kentucky mountain districts.

Courtesy of the Columbus Mining Company.

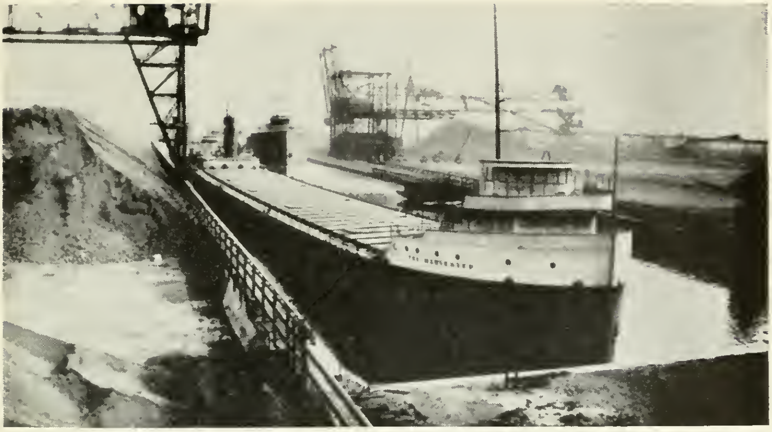

Plate 9.—The L. S. "Harvester" at the Coal Dock of the Wisconsin Steel Company. The same type of boat is used to move coal, ore, and limestone.

Plate 10.—A Limestone Quarry at Alpena, Michigan. The picture shows the various levels at which the stone is being quarried, and the series of railroad tracks by which it is assembled at the crusher. The thin overburden, about four feet thick at this point, can be seen clearly at the left of the picture.

Photograph by G. W. Hance, Detroit.

Plate 11.—The Ore Piles, Bridge Conveyors, and Blast Furnaces of the Iroquois Plant, South Chicago.

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